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SCIENTIFIC AMERICAN SUPPLEMENT. No. 1770

Entered at the Post Office of New York, N. Y., as Second Class Matter.
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Published weekly by Munn & Co., Inc., at 361 Broadway, New York.

Charles Allen Munn, President, 361 Broadway, New York.
Frederick Converse Beach, Sec'y and Treas., 361 Broadway, New York.

Scientific American, established 1845.
Scientific American Supplement, Vol. LXVIII., No. 1770.

NEW YORK. DECEMBER 4, 1909.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

UNLOADING HOP VINES INTO THE PICKING MACHINES

HOP CROP READY TO BE PICKED. THE HOPS ARE GROWN ON VINES TRAINED ON STRINGS TO A UNIFORM HEIGHT OF SIXTEEN FEET.

MACHINE-PICKED VS. HAND-PICKED HOPS.—[See page 331.]

THE STRUGGLE FOR THE POLE.*

A RECORD OF HEROISM.

BY WASHINGTON PLATT.

On September first the world was electrified by the news that the North Pole had at last been reached by Dr. Frederick A. Cook. Word was received from the Danish steamer "Hans Egede," which sent the following startling message from Lermick to Copenhagen: "Here on board is the American explorer, Dr. Cook, who reached the North Pole on April 21st, 1908, while on a North Polar expedition. Cook arrived in May, 1909, at Upernivik from Cape York. The Eskimos at York confirm the truth of Cook's journey." Five days afterward, Peary announced that he, too, claimed the honor of its discovery by a characteristic telegram which read: "Have made good at last. Have the old Pole. I reached it on April 6th, 1909. Stars and Stripes nailed to the North Pole." The goal of hundreds of expeditions, extending over more than three centuries and costing millions of dollars, had at last been attained.

Arctic expeditions have been attempted one after the other since the beginning of the sixteenth century. The first attempts were made with the hope of discovering the Northwest Passage, or route of communication with China across the Atlantic Ocean. The faith in the existence of such a passage was sustained because of the universal belief at that time, that ice could not form in the open sea.

The first expedition worthy of note after the preliminary explorations of Cabot, Frobisher and Davis, was made in 1596 by William Barentz, a Dutch navigator, who set out to win the large reward offered by his government to anyone who should complete a voyage to China by crossing the Arctic Ocean. After sailing north for several days, Barentz came upon the island of Spitzbergen, till then unknown. From thence, the party steered eastward, and rounding the north coast of Nova Zembla, they became imprisoned in the ice. Their ship becoming damaged, they abandoned her and built a large house on the nearby ice out of driftwood and planks from the ship. Here they lived all winter, supported by the bears and white foxes which they found in great abundance. In June they set out in two open boats taken from their former ship, and in these reached the harbor of Kola after suffering almost unendurable hardships. Their house was discovered still intact nearly three centuries later, looking as if they had just left it. Their cooking utensils were in the fireplace, a Dutch clock still hung on the wall; and among their books was discovered a history of China, the land which they had hoped to reach.

Eleven years later Henry Hudson, also attempting to find a water route to China, attained a northing of 80 deg. 23 min. 10 sec., and thereby established a record which was not broken for one hundred and sixty-six years. Sea captains, attracted by Hudson's account of the abundance of whale in the Arctic, now attacked the problem of living in the far North and extended the world's knowledge of the polar ice cap and the lands within the Arctic Circle.

Arctic exploration was begun in earnest in 1827, when Sir Edward Parry was given charge of a party by the British Admiralty. Parry, by providing himself with small boats with steel runners, was the first to anticipate the modern method of travel by sledges. Bad luck was experienced from the start in the shape of open leads and a southerly drift of the ice so that, though a new record was made, the party did not get within 500 miles of their goal. Fifty years later this latitude was extended by Capt. George Nares, another Englishman.

The first Americans to hold a record in the approach to the North Pole were Col. David L. Brainard and Lieut. Lockwood. These men were members of the United States International Polar Expedition, which was organized in 1881 purely for the purpose of making explorations and scientific observations. After doing work of immense value, the party retreated to Cape Sabine, where they were obliged to winter, owing to the tardiness of the relief expeditions. Game was scarce and 18 died of starvation before they were rescued.

A daring and original scheme for reaching the Pole was devised by Fridtjof Nansen, one of the greatest of Arctic explorers. This consisted in drifting with the ice across the Pole from the Siberian coast. The movement of the ice in this direction had often been noticed, driftwood from Siberia being found in great abundance on the coast of Greenland. For accomplishing such a perilous voyage, a ship was needed which could withstand the enormous pressure of the ice. Nansen had a vessel, the "Fram," constructed for him—the first one ever built which was designed exclusively for Arctic exploration. He himself was a born explorer and naturalist. He had already visited Greenland at the age of twenty-one, and later he crossed its elevated central plateau. He set out this time with high hopes for success.

The expedition in the "Fram" started in 1893 from the Sea of Kara, passed the New Siberia Islands and was frozen in, at latitude 78 deg. The ship, however, did not cross the Pole as Nansen had hoped, but drifted west-northwest till within a little over 300 miles from the Pole, when it changed its course to west-southwest. It remained in the ice over two years, not reaching home till 1896. When Nansen discovered the course which the ship was taking, he attempted a dash for the Pole by sledge. Three sledges, 26 dogs, and provisions for 100 days were taken. Rough ice made the going difficult, so after establishing a new mark of 86 deg. 12 min. they turned back. With but 77 days' food in the midst of the Arctic ice, they apparently faced death. Without losing courage, however, they struggled south, killing a dog from time to time to escape starvation. After 155 days' life on the ice pack they reached Franz Josef Land, where the winter was spent. In the spring they struggled on again till they reached Cape Flora, where the historic meeting with the Jackson expedition occurred.

The most daring of all attempts to reach the Pole was that of Salomon August Andree, a Swedish engineer. With two companions he set out for the polar regions from Dane's Island in an enormous balloon, the "Ornen" (The Eagle), which had been built in Paris especially for the purpose. Besides geographical and scientific instruments, Andree took with him a number of carrier pigeons in order to inform the world of his progress. Two days after his departure, one of his pigeons was caught. This was the last that was ever heard of him. Relief parties were sent out, but no traces were discovered.

Peary first appeared upon the scene of polar exploration in 1886, when he made his first voyage of exploration across the ice cap of Greenland. This was followed by others of a similar nature, in which he demonstrated that Greenland is an island, and mapped several of the smaller islands which lie to the north of it, separated by Peary Channel. To do this, he had to cross the ice crest of central Greenland, which rises 8,000 feet above sea level. On his fifth expedition into Greenland in 1896 and 1897, he brought back to New York three large meteorites, one of them the largest in the world. His first attempt to reach the Pole was made in 1899 and was followed by two more of a similar nature in 1901 and 1902; but, each time, the lack of a proper ship prevented exceptionally high latitudes from being reached.

It was not until he secured a ship built especially for the purpose, that he was able to establish a record and finally to reach the Pole. As long as he sailed in the ordinary Canadian sealers, he could not rely on them to carry him through the dangerous passage of Smith Sound, and thus was unable to establish a base of supplies within striking distance of the Pole. He therefore had to start his sledging expeditions from bases several hundred miles farther south. This prevented him from getting on to the real Polar ice cap till the season was already far advanced, and necessitated the transportation of a larger stock of provisions.

This ship which was to overcome these difficulties and contribute such a large share to his final success was built in 1904, largely through the generosity of Mr. Morris K. Jesup. Careful attention was given to each detail, profiting by the experience of the "Fram."

With such a splendid ship at his command, Peary started on his ninth Arctic expedition in 1905. The "Roosevelt" pushed as far north as Cape Sheridan before being finally stopped by the ice. From this point as a base, Peary set out, completely equipped, accompanied by 6 Americans and 21 Eskimos. He seemed in a fair way to achieve his goal, when his progress was blocked by an open lead. Having no boats, he was obliged to wait seven days for it to freeze over. Though this delay prevented the attainment of the Pole, nevertheless the party reached latitude 87 deg. 6 min., breaking all previous records.

On August 18th, 1908, Peary sailed out of Etah Ford in his final quest of the Pole. The "Roosevelt" wormed and fought her way through the ice and fog of Kennedy Channel as far as Cape Sheridan, where she was made snug for the winter, just south of the 83rd parallel. This was the farthest north ever reached by any ship. Work of transporting supplies and equipment to Cape Columbia, whence the expedition was to start, was carried on till winter set in.

The final success of this expedition was largely due to the wonderful organization of the party. No such carefully worked-out plan had ever been put into practice in any previous attempt to reach the Pole. All Peary's former experience in the Arctic was brought into play.

On February 15th, 1909, the first division of the party under Capt. Bartlett started from the "Roosevelt" toward Cape Columbia, where a base of supplies had been located the previous autumn. The other parties set out on successive days led by Goodsell, Borup, Yale '07, and McMillan. Peary himself did not leave the ship till February 22nd. In all there were 6 white men, 1 negro, 59 Eskimos, 140 dogs, and 23 sledges. Peary's plan was to let the supporting parties cut the trail and do the hard work, reserving all the strength of himself and of the few men who were to go with him for the final dash. The trail was very rough and much of the way had to be hewn through jagged ice. At different intervals the four supporting parties were sent back with a large part of the dogs and sledges. The gradual dwindling of the party may be seen from the following table:

	Men.	Dogs.	Sledges.
February 22nd, 1909....	66	140	23
March 1st	24	133	19
Sixth stage	16	100	12
Tenth stage	10	70	10
86 deg. 38 min.....	9	60	7
88 deg.	6	40	5

Capt. Bartlett was the last to return, leaving Peary with five companions in 88 deg. north latitude to make the final dash of 140 miles for the Pole.

Of the five men who accompanied Peary on this final attempt, two of them, Hansen and Oolam, had been with him when he had established a record two years previous; two others had been in Clark's division of the same expedition, which Peary had rescued. The fifth was making his first polar trip, but was, if possible, more full of enthusiasm than any of the others, as he relied on the gifts which Peary had promised him, to win the girl on whom he had set his heart. All "were as responsive to his will as the fingers of his right hand."

During the first part of the journey the weather was fine, though the ice was rather rough, and the sledges had to be hauled over great ridges of ice. Inside of the 89th parallel a lead of water but thinly frozen over was encountered. The ice swayed and bent as their sledges were hurried across, and broke as the last one left it. One of these leads of open water had prevented Peary from reaching the Pole on his former expedition, and the fear of encountering one lying like a barrier across his path was constantly in Peary's mind.

The weather now became thick. "The horizon was black and the ice beneath was a ghastly chalky white with no relief—a striking contrast to the glimmering sunlit fields of it, over which we had been traveling for the previous four days." The surface, however, was smoother, so that in the last few days of the march, the remarkable average of 35 miles a day was made.

An observation on April 6th, 1909, showed a latitude 89 deg. 57 min. A few hours later he had reached his destination. The following entry appears in Peary's journal:

"The Pole at last! The prize of three centuries, my dream and goal for twenty years, mine at last! I cannot bring myself to realize it."

Thirty hours were spent at the Pole making observations. The next day the return journey was begun. This was made with little difficulty as the party could follow back the same trail that they had just made on the approach. On April 23rd they reached Cape Columbia. The Eskimos went wild with joy, shouting: "The Devil is asleep or having trouble with his wife, or we never should have come back so easily." In four days the "Roosevelt" was reached, and on September 5th, from Indian Harbor, the news was flashed by wireless over the civilized world.

Wonderful as Peary's exploit seems, however, Dr. Cook's seems even more wonderful. Peary had made nine former Arctic expeditions, Cook but two. Peary's final dash was made with five men besides himself; Cook employed but two others. Peary had already established a record in Arctic research; while though the doctor had been on two expeditions, once with Peary

* Yale Scientific Monthly.

in 1891, and in the Belgian Antarctic expedition in 1897, he had never reached any especially high latitudes. His most notable feat had been the ascent of Mount McKinley, the "top of the continent," in 1903.

The present expedition was outfitted in July, 1907. Financial backing was provided by Mr. J. R. Bradley, after whom Dr. Cook's ship was named. The journey was undertaken primarily for the purpose of enjoying the big game hunting which the Arctic provides; but the possibility of also making a dash for the Pole was prominent in the minds of both.

When the ship reached Etah, after they had enjoyed the shooting at North Star Bay, they found that a bear hunt was being organized. Eskimos and dogs had gathered from miles around. This excellent opportunity to pick the strongest Eskimos and dogs from such a large number was the most powerful influence in leading Dr. Cook to attempt a dash for the Pole.

The winter was spent at Anootok, as his ship could not penetrate as far north as the "Roosevelt." On February 19th, 1908, the party consisting of Dr. Cook's 10 Eskimos, 103 dogs and 11 sledges, set out toward Ellesmere Land in a temperature 83 deg. below. The land route was chosen on account of the abundance of the game. Their bag averaged 3 musk oxen and 11 hares a day; so they were not obliged to make inroads on their supplies till they left Land's End.

Sixty miles north of this point Cook's final support turned back and left him to prove his theory, that one white man with native help could reach the Pole better than a large party. His final success, however, was partly due to good luck; for if the ice had been rough, such a small party could never have gotten the loaded sledges over the high ridges. As it was, many detours had to be made which consumed much valuable time.

At longitude 86 deg. 36 min. and latitude 84 deg. 17 min., the land was seen in the west, probably the earth's northernmost rocks; but time did not permit their exploration. An icy wind continued to make life almost unbearable though the surface of the ice became smoother and smoother as they approached the Pole. When still more than 200 miles from the Pole, the first of his dogs was killed for food. By pushing their endurance to the utmost, and making from 14 to 28 miles a day the Pole was finally reached on April 21st, 1908, a year earlier than Peary.

The two days spent here taking observations cost him dear. The pack had already begun its summer disintegration, increasing the difficulty of travel. A few days' journey from the Pole, violent gales and later a thick fog were encountered, which prevented the taking of observations.

Open water prevented the return to Heiberg Land where large caches had been left, and provisions were nearly exhausted when providentially a bear was shot. Pushing on, they reached North Devon, but the season was already so far advanced that they were obliged to winter there. Their condition was desperate. The ammunition was exhausted and they were obliged to secure food in the Eskimo way by means of the bow and arrow, the lance, the knife, and the fish line. With the returning sunlight they made their way back to Etah.

The North Pole itself, in the quest of which so many lives have been lost, must be a strangely cheerless spot. Life of every kind has vanished. Here is Dr. Cook's depressing description: "A sense of intense loneliness swept us. What a cheerless spot to have aroused the ambition of men for so many ages! An endless field of purple snows. No life, no land, no spot to relieve the monotony of frost. We were the only pulsating creatures in a dead world of ice."

According to Peary's soundings, the ocean at the Pole is over 9,000 feet deep. The ice, however, is comparatively smooth, because of its distance from land. Extremely low temperatures were not recorded by either explorer. Peary's lowest while at the Pole was but 33 deg. below, and Cook's 38 deg. below.

From a theoretical point of view, however, the North Pole is an extremely interesting place. Here a parallel of latitude is reduced to a single point, and longitude entirely vanishes! Time also vanishes, as it is always local noon. All winds blowing over the Pole, blow *from* the south and also *toward* the south at the same time. The magnetic needle points due south The stars do not rise and set, but describe a circle around the horizon. The North Star is not directly overhead, but describes a circle four and one-half times as broad as the sun's face. If a man should walk toward west on a parallel of latitude three and one-half miles from the Pole, at the rate of one mile an hour, he would be traveling east at the same velocity with which that part of the earth is going west. He, therefore, would not be moving at all, but would be simply treading the earth under his feet in the same way that a dog walks on a rolling barrel.

What will be the results of the discovery of the Pole? Of course, to humanity the benefits will be *nil*. The Pole is useless as a dwelling place and nothing useful in everyday life has ever been brought from the extremely high latitudes. To science, however, these two expeditions are of the greatest importance. A knowledge of the ocean depth, winds, and temperature at the Pole are of the greatest value in geography and meteorology. The two expeditions have, moreover, cut a triangle of 30,000 square miles from the Arctic unknown. Another very important result of the discovery of the Pole will be that in the future, explorers anxious for fame will have their attention attracted from the mere attainment of latitude 90 deg., to making more careful observations in the lands already known. Finally, the story of the attainment of the Pole will always stand as a glowing chapter in human achievement, inspiring to all who read it.

AT THE NORTH POLE.

ASTRONOMICAL AND GEOPHYSICAL CONDITIONS.

BY PROF. MESSERSCHMITT

THE attainment of the North Pole by Cook and Peary has reawakened interest in the astronomical and geophysical conditions which exist in that region.

The north pole of the heavens, about which all the stars appear to revolve, lies in the horizon of an observer stationed at the earth's equator, while its altitude, or angular elevation above the horizon of any other place of observation is equal to the geographical latitude of that place. At the North Pole of the earth, therefore, the celestial pole is in the zenith, the celestial equator coincides with the horizon, the stars of the southern hemisphere are invisible and the stars of the northern hemisphere do not rise and set, but describe horizontal circles.

The sun, pursuing its annual journey round the ecliptic, which is inclined to the equator, appears north of the equator in our summer and south of the equator in our winter. At the North Pole, therefore, the sun is continuously above the horizon in summer and below it in winter, so that six months of daylight are followed by six months of night.

At the North Pole all meridians meet and every direction is south. Hence the fixed meridian, upon which the determination of longitude and time depends, is lacking, and it is necessary to assume an arbitrary direction as the meridian. Then the sidereal day is the interval between successive passages of a star, and the true solar day is the interval between sucessive passages of the sun, over this assumed meridian. Greenwich time is obtained only if the assumed direction coincides with the meridian of Greenwich. Any error in the choice of the meridian vitiates the determination of time, and great errors can be avoided only by taking observations of lunar distances.

In determining the latitude by measuring the altitude of the sun it is necessary to know the exact time, in order to find the sun's true place from the tables. An error of one hour, which may easily be made in these latitudes, would introduce, in April, an error of one minute of arc in the latitude. As the pole was reached by Cook on April 21st, 1908, and by Peary on April 6th, 1909, the determination of the time was a serious matter for both explorers.

Atmospheric refraction also introduces great uncertainty into astronomical observations in polar regions. The effect of refraction in increasing the apparent altitude of a heavenly body increases from zero at the zenith to 35 minutes of arc at the horizon, in temperate latitudes. When the sun or the moon is very near the horizon it appears oval, because the lower edge is raised by refraction more than the upper edge. Upon objects high above the horizon the effect of atmospheric refraction is not only small, but regular, so that it can be calculated and applied, as a correction, to the observed altitudes. Very near the horizon, on the contrary, the refraction is both great and irregular, so that the observations cannot be corrected with certainty, and the uncertainty is greatly increased in the polar regions, as all explorers have found. The following examples illustrate the magnitude and variability of the effect of refraction in these conditions. Nummelin passed the winter of 1876 on the island of Briochowski at 70.8 deg. north latitude. He saw the sun for the last time before the winter night on November 21st, and it reappeared on January 19th. On both of these days the sun was really so far below the horizon that it must have been elevated one degree by refraction in order to become visible. A Dutch expedition passed the winter of 1596 at 76 deg. north latitude. The sun disappeared on November 14th and reappeared on February 3rd. To produce this result the refraction must have amounted to five degrees. Determinations of latitude made in these conditions would be affected by errors ranging from one degree to five degrees, equivalent to from 60 to more than 300 miles, measured on the earth's surface.

Fortunately the uncertainty caused by refraction rapidly diminishes as the altitude increases. When Cook reached the pole the sun stood 12 deg. above the horizon, at which altitude the normal correction for refraction is only 4 minutes of arc. In Peary's case the sun's altitude was 7 deg. and the normal refraction 8 min. Even if the errors in the latitude caused by refraction are supposed equal to the total normal refraction, they would amount only to 4 and 8 min, equivalent to 4.3 and 8.7 miles, respectively. The effect of errors of observation and the uncertainty of the time should also have been small, so that it may be assumed that the position of the pole can be determined, with the instruments usually carried by Arctic explorers, to within about 6 miles.

Both Cook and Peary locate the North Pole in the sea amid rapidly drifting ice. According to Shackleton, the South Pole is situated on an extensive high plateau.

The determination of the force of gravity near the pole, by Scott Hansen, of Nansen's expedition, is valuable in itself and interesting as the first measurement of the kind made at sea.

The magnetic phenomena of polar regions are especially interesting and important. The magnetic North Pole was found by Ross on the island of Boothia, at 70 deg. 30 min. N. lat. and 97 deg. 40 min. W. long., almost 20 deg. distant from the geographical North Pole. The magnetic South Pole is situated at 72 deg. 50 min. S. lat, and 156 deg. 25 min. E. long. At these points the dipping magnetic needle stands vertical, i. e., the magnetic inclination is 90 deg. The inclination decreases in an irregular manner as the distance from the magnetic pole increases and no special peculiarity in magnetic inclination or intensity is observed near the geographical poles. The magnetic declination, i. e., the angle which the compass needle makes with the meridian, also varies irregularly over the earth's surface. At the geographical poles the magnetic declination is affected by the uncertainty which attaches to the meridian itself, but the direction of the compass needle, relatively to the earth's surface, is perfectly definite. It leads to the nearest magnetic pole and constitutes an important line of reference.

Exact measurements of the magnetic elements in the immediate vicinity of the geographical poles would be of great value, but it is impracticable to carry the requisite instruments on long sledge journeys. The expeditions of Nansen, Sverdrup, and other Arctic and Antarctic explorers have been well equipped with apparatus for making magnetic measurements.

Closely connected with terrestrial magnetism are the auroras which shed their mysterious radiance over the long polar nights. The phenomena of auroras extend through a zone, the center of which is near the magnetic pole, but the maximum effect is observed at a considerable distance from this pole. Inside this belt of maximum effect, auroras are seen to radiate from points both north and south of the zenith, but at places outside the belt they stream only from the north. There appears to be an intimate relation between the distribution of auroras and that of barometric pressure in polar regions.—Prometheus.

By far the heaviest train ever hauled by one locomotive on any railway in the United States, and probably in the world, says the Iron Age, has been moved over the Pennsylvania Railroad, between Altoona and Enola. On June 22nd a single locomotive, built at the company's Altoona shops, pulled a train of 105 steel cars, loaded with 5,544 tons of coal, for 127 miles in 7 hours and 12 minutes, or at an average speed of 17.6 miles an hour. The entire train, including engine, weighed 7,644 tons, and stretched along the line for 3,600 feet. That part of the line over which the test was made from Altoona to Enola presents at no point a greater gradient than 12 feet to the mile.

WIRELESS TELEGRAPHY AND TELEPHONY.

A RECORD OF RECENT PROGRESS.

BY H. MARCHAND.

ALTHOUGH scarcely ten years have elapsed since Marconi's first really conclusive experiments, wireless telegraphy has already become an art. A marvelous number of excellent types of apparatus has been invented, and within the last two or three years, many instruments of great interest have been devised.

I. PRODUCTION OF AERIAL WAVES.

In transmission, the improvements consist especially in the production of sustained or undamped waves, and in the employment of lower frequencies than those first used. The ordinary electric spark has many inconveniences. It produces trains of waves which are rapidly damped, irregular, and discordant. Hence it is necessary to use large quantities of energy to produce a useful effect. The antennæ are lofty, the electromotive force is high, and the receivers are sensitive to all frequencies and are consequently easily influenced by atmospheric electricity.

Undamped vibrations are much better. They are in tune with each other, and their effects upon the receivers are added by resonance, so that the receivers are operated with less expense of energy; interferences are more easily avoided; the tension required is lower;

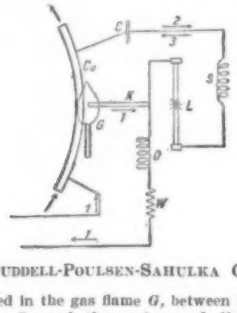


FIG. 1.—DUDDELL-POULSEN-SAHULKA OSCILLATOR.

The arc is formed in the gas flame *G*, between the water-cooled copper tube *Cu* and the carbon rod *K*. *W*, resistance coil; *D*, reactance coil; *C*, battery of Leyden jars; *S*, primary of Tesla coil; *L*, auxiliary arc between carbon electrodes.

the height of the antenna can be diminished; the syntonization is improved, and telephony becomes possible. Such undamped vibrations are produced by the following methods:

1. The Arc Method.—Several processes make use of the blown arc or Duddell's singing arc, which was first used by Lecher and Thomson, and later by Blondel and Campos for the production of currents of high frequency. Among the best of these methods is that of Poulsen (Fig. 1) in which the arc is produced, with a tension of 500 volts, in an atmosphere of hydrogen, illuminating gas, or alcohol vapor, or in a bath of vaseline. Alcohol is very convenient and most commonly used, and the arc is regulated by hand to a length of ⅛ inch. The arc is inclosed in a box with a perforated cardboard cover, together with two choking coils which prevent the return of the oscillating currents to the source. The effects of these coils is remarkable, and is manifested by the great elevation of temperature of the end of each coil nearest the arc. The source is an ordinary direct-current dynamo.

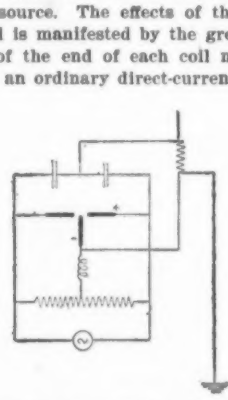


FIG. 2.—EISENSTEIN OSCILLATOR, WITH ARC FORMED BY ALTERNATING CURRENT BETWEEN A CARBON CATHODE AND COPPER ANODES.

Galetti has experimented with a very similar system, containing two oscillators which react upon each other, and are operated by a Thury dynamo of 20,000 volts. He has obtained encouraging results, and intends to continue the experiments with a tension of 40,000 volts. The waves are produced by spark discharges.

Eisenstein, in his patent of 1907, claims the employment of an alternating current with two metallic anodes and a cathode of carbon, the arc being formed alternately on each side of the carbon, and the production of waves thus being rendered continuous (Fig. 2). Peukert has proved by experiment that, even with a single anode, the alternating may be substituted for the direct current, and he has obtained oscillations of a frequency of 10^6 with an arc of 50 periods.

On the other hand, the Gesellschaft fuer drahtlose

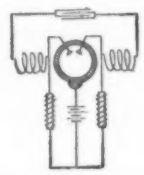


FIG. 3.—VREELAND OSCILLATOR, WITH MERCURY VAPOR TUBE.

Telegraphie proposes to use, especially for telephony, several Duddell arcs of low tension, in series, in a circuit of 500 volts; the arcs being formed between a cooled metal electrode and a carbon electrode.

Finally, the new system of the Lepel company, devised to make the most economical use of energy, employs arcs of 400 or 500 volts formed between hollow circular electrodes, which are cooled by a current of water and separated by a sheet of paper, the combustion of which produces the special atmosphere which Poulsen obtains by the methods indicated above.

2. Mercury Lamp Methods.—Undamped vibrations can also be obtained by means of the mercury-vapor lamp. This device was indicated by Cooper Hewitt, and experiments appear to indicate that it should give good results.

Vreeland has recently devised a similar system, in which the oscillating currents are made to react upon the arc itself, by employing a tube with two anodes for the purpose of obtaining sinusoidal waves of perfectly definite but adjustable frequency (Fig. 3).

3. Mechanical Generators.—The most important method appears to be that of Fessenden, using a mechanical generator. The mechanical production of reg-

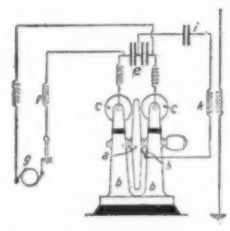


FIG. 4.—MARCONI OSCILLATOR, WITH SPARKS FORMED BETWEEN ROTATING DISKS.

a, central disk; *bb*, supports; *cc*, lateral disks; *h*, brush; *e*, condensers; *g*, dynamo; *f*, inductances; *i*, condenser; *k*, jigger.

ular waves had already been attempted in various ways. Fessenden himself experimented with the dynamo-condenser, but was led finally to the employment of the alternator.

In 1906 Fessenden made his first practical experiments with an alternator of high frequency. An alternator of this kind had already been devised by Thomson, and in 1900 Duddell had constructed one capable of giving 120,000 periods, which he employed in his researches on the resistance of the voltaic arc. Other machines of the same class have also been invented. The alternator at present used by Fessenden furnishes currents of 100,000 periods, 7 or 8 amperes, and 160 volts. It is driven by a small steam turbine. The most characteristic part of the apparatus is the regulator, which is of the resonance type devised by Fessenden, and which regulates the speed within 1/20 per cent. The results obtained with this alternator are very remarkable, and although the machine is of comparatively low power, great distances have been covered by day as well as by night. Fessenden attributes his success largely to the employment of very low frequencies, the advantages of which he pointed out in 1906. The superiority of long waves is due essentially to the fact that these waves are less absorbed by obstacles, which they pass around more easily by the process of diffraction.

4. Spark Discharge Methods.—Marconi still uses the spark discharge, but in order to obtain approximately continuous sparks and oscillations, he causes the electrodes to move with sufficient rapidity to prevent the opposed surfaces becoming sufficiently heated to allow the formation of an arc between them. The electrodes may be of any form. This arrangement is several years old, but it has recently been improved in construction and detail, rather than in principle. One of the improvements consists in the employment of an electrode in the form of a disk rotating very rapidly between two other disk electrodes placed normally to its plane. The central disk bears around its edge elevations which produce strong sparks as they pass the outer disks (Fig. 4).

Marconi and Fleming place the oscillator in a compressed inert gas; Marconi blows the spark with a current of air; in the Telefunken system, the sparks are formed between two revolving rings; in France, rotating cylinders are frequently used as electrodes.

Lodge has recommended the replacement of the spark gap by a discharger with pointed electrodes, surrounded by an ionized gas. In any case the current may be either direct or alternating, but the alternating current should be represented by a curve with flattened summits rather than by a sinusoid.

II. RECEIVING APPARATUS.

The most remarkable detectors are Fessenden's barreter, De Forest's audion, the thermo-electric devices,

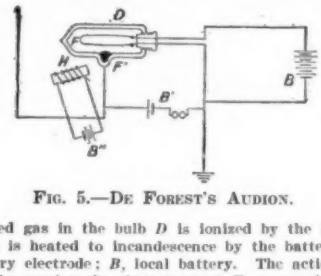


FIG. 5.—DE FOREST'S AUDION.

The rarefied gas in the bulb *D* is ionized by the filament *F*, which is heated to incandescence by the battery *B*. *F'*, mercury electrode; *B*, local battery. The action is regulated by moving the electromagnet *H*, or varying the current which energizes it.

and the rectifiers. The coherer may be regarded as obsolete. Marconi uses his magnetic detector with hysteresis; Fleming has tested an ionized gas rectifier which presents some analogy to De Forest's audion; the German wireless telegraph company employs very largely the electrolytic detector of Schloemilch, which is also used in all the French postal stations.

Pickard has invented a detector which he calls "perikon," with an imperfect contact between a crystal of chalcopyrite and a crystal of zincite. Brenot, who has examined this arrangement, has shown that detectors of this type are veritable dry batteries.

1. The Barretter.—There are two forms of barretter, the wire and the liquid form. Both are very sensitive, but the latter is less fragile. These devices are too well known to require description. The liquid barretter detects currents of a frequency of 5,000 periods per second, a strength of 6×10^{-5} amperes, and a tension of 15×10^{-5} volts. It is very suitable for use in telephony.

The barretter is only a modified bolometer. Even the operation of the liquid barretter, which has sometimes been regarded as electrolytic, depends almost exclusively upon the heating effect of the vibrations. Experiments made by Austin of the U. S. Bureau of

FIG. 6.—WALTER'S TANTALUM DETECTOR.

P, platinum rod dipping into mercury bath *M*; *P'*, the platinum rod carrying two or three tantalum wires which can be bent toward or away from the mercury by a rod inserted through the orifice *O*.

Weights and Measures prove that the electrolytic action plays a very subordinate part. Nevertheless, Fessenden, in his patent of 1907, arranges the detector in such a manner that the gas formed at the anode of the ordinary apparatus, is carried away by a liquid current into a narrow passage, where it can interrupt the local electric current.

2. Thermo-Electric Detectors.—There are many types of thermo-electric detectors. These are based upon the Seebeck effect, and may be formed of any substances far removed from each other in the thermo-electric series. If both substances are metals, they

are used in the form of fine wires. If either is a non-metal, this is cut into a wedge or prism with sharp edges. The thermo-electric element is inserted into the circuit in such a manner that the heating effect of the aerial waves is concentrated upon the thermo-electric junction. Among the newest detectors of this class are those of Austin, Pickard, Dunwoody, and the Gesellschaft fuer drahtlose Telegraphie. Austin's apparatus is composed of a wedge of tellurium mounted

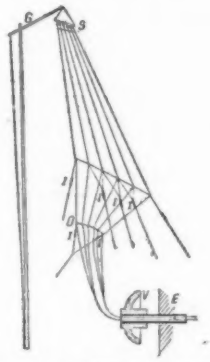


FIG. 7.—DE FOREST ANTENNA.

G, mast; *S*, bar to which antenna wires are attached; *I*, insulators of stay wires; *V*, insulator; *E*, inlet to operating room.

on a stiff wire, and pressed by a spring against a rod of silicon. Pickard's device consists of a metal point pressing upon a plate of silicon. In the German apparatus, the element is heated from outside to a normal temperature, and the heating caused by the aerial waves simply modifies the strength of the local current thus produced. The thermo-element is formed of a plate of copper which has been oxidized by a flame, and a platinum wire touching the plate. Dunwoody uses a crystal of carborundum clamped between two conductors or attached to a wire, and immersed in a conducting solution.

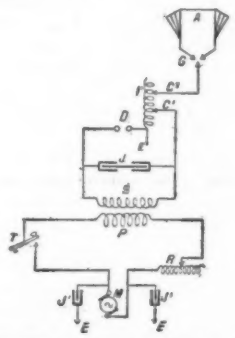


FIG. 8.—DE FOREST TRANSMITTING APPARATUS.

M, alternator; *J'*, Leyden jars which absorb the oscillations of the transmission circuit; *R*, adjustable resistance; *T*, Morse key; *PS*, transformer; *J*, Leyden jars; *D*, spark gap; *I'*, inductance coil; C^1 C^2, leads; *G*, auxiliary spark gap; *A*, antenna.

There is no increase of energy in any apparatus of this kind. The energy received is simply transformed, first into heat, and then again into electrical energy. Eccles finds thermo-electric couples of tellurium-galenium, tellurium-molybdenum, and selenium-galenium about as sensitive as the electrolytic detectors. According to Eccles, the operation of the apparatus is not due entirely to the Seebeck effect, but in most cases there is also a rectifying action. Brandes and Pierce have proved this for certain crystals. Hence the action is not confined to the point of contact of the

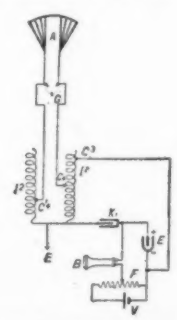


FIG. 9.—DE FOREST RECEIVING SYSTEM WITH ELECTROLYTIC DETECTOR, TELEPHONE, AND DOUBLE ANTENNA.

I, variable inductances; *E*, electrolytic detector; *K*, condenser; *V*, primary battery; *F*, potentiometer; *B*, telephone; *A*, antenna; *G*, auxiliary spark gap.

crystal with the metal, but is distributed through the mass. Austin has arrived at the same conclusion.

3. Rectifiers.—G. W. Pierce has obtained several patents for rectifiers employing carborundum, tellurium, and oxide of titanium.

4. Vacuum Tubes.—The vacuum tube, which Elster and Geitel found capable of rectifying alternating currents, has been taken up in a slightly modified form by Fleming. De Forest's audion (Fig. 5) is a vacuum tube with a special mounting, which causes it to act as a relay, and not merely as a valve. The device which, according to the inventor, constitutes the whole value of the apparatus, is the insertion of a galvanic battery into the circuit of the ionized gas and the receiver. The instrument is formed of a 6-volt lamp heated by three storage batteries. The auxiliary battery of 6 to 18 volts may be composed of dry cells. A tantalum lamp is preferable to one of carbon, platinum, or tungsten. The vacuum should not be very high, if great sensitiveness is desired.

Detectors of this class have the great advantage of strength and durability. They can be made on a large scale like incandescent lamps.

Important modifications are described in De Forest's patent of February, 1908. The principal improvement is the addition of a bent platinum wire, which is placed in the lamp between the filament and the aluminium electrode. This wire is connected with the receiving circuit through a condenser. It greatly increases the sensitiveness.

5. Electrolytic Detectors.—The extensive employment of electrolytic detectors is sufficient evidence of their excellence. In particular, very good results have

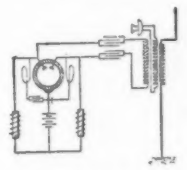


FIG. 10.—VREELAND TRANSMITTING APPARATUS FOR WIRELESS TELEPHONY.

been obtained with an electrolytic detector having a tantalum point (Fig. 6). With this instrument speech has been transmitted 500 miles with a power of 2 kilowatts. A modification including a galvanometer is described in the German patent 190,639 of 1908. The older magnetic and electrolytic detectors are, as a rule, steadier and more easily regulated than the newer types.

III. AUXILIARY APPARATUS.

The auxiliary apparatus, including transformers, condensers, induction coils, antennæ, etc., have been less changed and improved than the transmitters and detectors. The modifications which have been introduced have been made necessary by the great amount of energy now used. In particular, an attempt has been made to simplify the connections.

1. Antenna.—No new form of antenna has appeared recently. The bare or insulated wire, carried by a kite or balloon, the prismatic antenna with an elevated support (for short waves), the vertical plane antenna (coast stations), the horizontal plane antenna, and

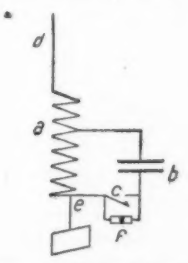


FIG. 11.—PEDERSEN'S TICKER RECEIVER, USED WITH A COHERER.

ad, antenna; *b*, condenser; *c*, ticker; *e*, earth wire; *f*, coherer.

Blondel's plane or conical antenna are still employed, according to local conditions and range.

Attempts have been made to simplify the construction of the antennæ, and several special forms have been patented (Fig. 7). The endeavor is to construct cheaply an antenna of large area, possessing, without the addition of auxiliary coils, a period closely approximating to that of the oscillator. This tendency is well shown by the umbrella-shaped antenna of the Gesellschaft fuer drahtlose Telegraphie.

2. Condensers.—Leyden jars and Moscicki tubes have been superseded by plate condensers containing no solid dielectric. Thus we have the old condenser of Aepinus (Marconi). Sometimes compressed air or inert gas is introduced between the plates (Fleming, Fessenden) in order to increase the resistance and reduce the dimensions of the apparatus. Pletts has patented an adjustable plate condenser, which has twice the capacity of an ordinary condenser of the same size. It is formed of semicircular plates, alternately fixed and movable round an insulating axis by which they can be displaced relatively to the fixed plates.

3. Inductance.—A curious adjustable inductance coil devised by Tissot consists simply of a coil surrounded by a metal cylinder which is slit longitudinally. The slit can be closed more or less completely by a sliding piece, the position of which indicates the value of the inductance.

4. Transformers.—Inductance coils operated by direct current have been replaced by transformers receiving alternating or intermittent direct current. Fessenden uses an adjustable transformer in which the two coils can be removed from the working core to another metal core, which annuls the effect of that part of the coil which surrounds it. The best interrupter is that of Klingelfuss, immersed in a mixture

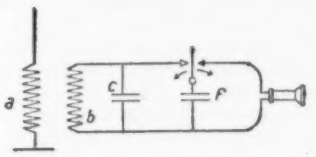


FIG. 12.—POULSEN TICKER RECEIVER, USED WITH A DETECTOR.

ab, jigger; *cf*, condenser.

of petroleum and mercury, which amalgamates the surfaces and insures perfect contact between the brushes and the revolving drum.

5. Transmitters.—In practice, the Morse system is used exclusively. In the spark method of producing the waves, about 14 words can be transmitted per minute. With undamped vibrations, greater speed can be obtained. In every case, the key, which is placed in the primary circuit (Fig. 8), must be so constructed as to support great wattages.

Interesting experiments in automatic transmission by a modification of the Wheatstone system have been made by Marconi, Poulsen, Fessenden, and British government officials.

In 1905 Marconi announced a speed of 100 words per minute, but the officials of the British Post Office, in repeating his experiments, were able to transmit only 70 words per minute between two stations about 16 miles apart. Poulsen has since transmitted 150 words

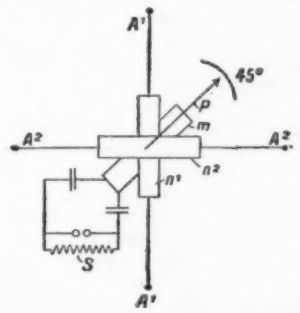


FIG. 13.—BELLINI AND TOSI TRANSMITTING APPARATUS FOR DIRECTED WAVES. (HORIZONTAL PROJECTION.)

A^1A^2, antennæ; n^1n^2, coils attached to antennæ; *m*, movable coil connected with oscillating circuit.

per minute, and Fessenden claims that he can transmit 250, and expects soon to be able to transmit 500 words per minute.

6. Receivers.—In long-distance transmission the signals are commonly received by means of a telephone, as the very sensitive apparatus employed does not allow the use of a recording receiver. It is probable, however, that this defect will soon be remedied.

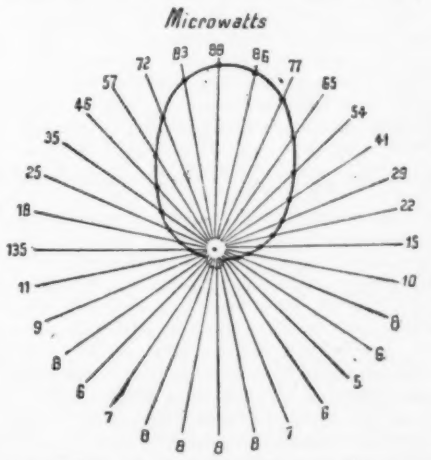


FIG. 14.—DIAGRAM SHOWING THE DISTRIBUTION OF WAVES BY THE BELLINI-TOSI APPARATUS.

The measurements were made with the Duddell thermo-galvanometer.

The telephone is bridged between the poles of the electrolytic or other detector, together with a battery and a rheostat (Fig. 9).

The principal methods of recording messages are

those of the Gesellschaft fuer drahtlose Telegraphie and of the Amalgamated Radiotelegraph Company. In the former, the electrolytic detector is combined with a relay, having a movable coil. In the latter, a chord galvanometer acts as a microphonic relay.

In the experiments in automatic transmission made by Marconi and the British Post Office, a siphon recorder was employed. Poulsen obtained the great speed indicated above with the aid of Rieder's photographic recorder. This apparatus comprises an Einthoven galvanometer, a camera, a clockwork moving the photographic film, and the appliances required for developing and fixing. The Einthoven galvanometer contains a wire of gold, silver, or platinum, or a filament of platinized quartz, stretched in a powerful magnetic field. The filament is traversed by the electric current and carries a little disk, the shadow of which is thrown by an electric lamp upon the sensitive film. The film emerges, developed and fixed, six seconds after the arrival of the signals, and shows images of the filament in white on a black ground. The apparatus is even more sensitive than the telephone, and it presents the advantage that an intelligent operator soon learns to distinguish the effects of atmospheric electricity from the images corresponding to the messages.

Fessenden has suggested the employment of a microphonic relay consisting of two opposed coils capable of rotation between the poles of an electromagnet. Gardner recommends the employment of a tuned telemicrophone, which has already been used with an electrolytic detector in Indo-China. Another suggestion is to amplify the received waves by means of a dynamo of special construction. Alexanderson in America has obtained a patent for the amplification of weak (telephonic) currents by means of an alternator.

7. Telephony.—In wireless telephony the apparatus does not differ in principle from that described above, except for the addition of a microphone to the transmitting apparatus. The greatest difficulty, and perhaps the only one when undamped vibrations are used, is to construct a microphone capable of carrying the large quantities of energy which must be employed. Majorana has obtained good results with his dropping microphone. Poulsen employs an ordinary microphone, or a number of them for long distances. Fessenden uses a microphone of the granular type with electrodes cooled by a current of water. The electrodes are made of platinum-iridium, and are separated by a ring of steatite. The microphone may be inserted in the primary circuit or between the antenna and the ground. Vreeland uses a Cooper Hewitt tube in a circuit which acts inductively on the antenna circuit (Fig. 10). Fessenden has made experiments by acting upon the inductor of the alternator. The same experimenter has succeeded in connecting an ordinary telephone circuit to a wireless system by means of an appropriate relay. The telephone employed is usually an ordinary receiver with a specially wound coil (as used in receiving wireless telegraphic messages). Fessenden, however, recommends a special telephonic receiver, such as Thomson's, in which the coil is attached to the vibrating membrane, and an amplifier (a small iron disk) is placed near the mouth of a tube from which compressed air flows. The movements of the disk produced by the electric current react upon the current of air, which in turn causes a second membrane to vibrate.

IV. METHODS OF OPERATION.

1. Formation of Signals.—In order to derive the greatest advantage from the system of undamped vibrations, these should be produced in a continuous manner, the signals being made by interrupting the accordance between the two stations. For example, Poulsen and Pedersen connect the oscillating circuit to the antenna by means of a number of turns of wire and the Morse key short-circuits some of the coils, and temporarily destroys the syntonization. This method is commonly employed, although it has inconveniences, of which the most serious are the instability of the arc and the rapid deterioration of the surfaces of contact. To remedy these defects, Poulsen suggests modifying the intensity of the vibrations by acting upon the current of gas, which he causes to flow between the electrodes. This modification may be effected: First, by hand (ordinary transmission); second, by a perforated ribbon (automatic transmission); third, by a manometric capsule (telephony). No account has been published of experiments with this system, which appears very ingenious and superior to all others in facility of transmission, with the exception of Fessenden's system of acting upon the inductor. Fessenden also operates by producing waves continuously and interrupting the concord of the circuit for the transmission of signals.

The ticker method (Fig. 11) invented by Pedersen and improved by Poulsen (Fig. 12) consists in the insertion in the receiving circuit of an intermittent contact, or vibrator, in such a manner that in one position of the vibrator the oscillating circuit is closed through the latter, while in the other position its energy is conveyed to the receiver. The ticker is simply a Neef vibrator inclosed in a flat iron box. It supersedes the detector, but it can be used only for telegraphy, as telephony requires a continuous receiver. An apparatus of this character is indispensable in the method of undamped vibrations, in order that the signals shall be perceptible in the telephone which otherwise would only give a click.

In the Marconi system the vibrations are produced by the points of the revolving disk. In Fessenden's heterodyne system a local field, produced by an alternating current, interferes with the field produced by the incoming waves, in such a manner that perceptible beats are produced.

2. Connection of the Circuits.—There are no novelties to report in this department. In the receiving apparatus connection by induction is commonly employed, but a conductive connection is established when the apparatus is not working, in order to insure the reception of call signals. By a very ingenious arrangement of circuits similar to that devised by Edison, Fessenden has succeeded in sending telephonic messages in both directions simultaneously.

3. Multiple Communications.—The device mentioned above also allows the same antenna to be used simultaneously for telegraphic transmission and reception, thus establishing a duplex system. Fessenden asserts that this method of working is more reliable in wireless than in ordinary telegraphy, because it is far easier to maintain equilibrium between the real and the artificial antennæ than between telegraphic circuits.

The facility of tuning attained with undamped vibrations gives a hope that we shall soon succeed in establishing multiple telegraphy, or at least that this problem will not offer greater difficulties than those of multiple telephony. At present it may be said that accord can be obtained within about five per cent. The difficult point, however, is to make each station independent of neighboring stations. Poulsen has sent duplex messages over a distance of 1,250 miles.

4. Directed Waves.—Aside from Zenneck's theoretical researches the only really notable experiments made with directed waves are those which have been carried on in France during the last eighteen months by Bellini and Tosi. Their process is based on principles similar to those enunciated by Blondel in 1898. Each station has two triangular antennæ open at the top and placed at right angles to each other. The effect of this arrangement is to cause the waves to interfere in such a manner that they are neutralized in one direction and reinforced in the perpendicular direction. The direction of the train of waves can be changed very simply without displacing the planes of the antennæ. Each antenna is excited by a coil placed in the middle of the lower side. The two coils which, like the antennæ, are situated in perpendicular planes, surround a common inducing coil which is movable and is connected with the circuit of the oscillator. The direction of the waves varies with the position of the movable coil (Fig. 13). The zone of influence consists of two parts which are placed symmetrically with respect to the transmitter and have the form of a flattened ellipse (Fig. 14). The angular aperture of the pencil of rays does not exceed ten degrees at a distance of fifty miles.

V. RESULTS.

I will conclude this brief sketch by citing a few records which have been recently made. In telegraphy, the most remarkable results are the following:

Lodge operates regularly between Burma and Adaman, a distance of 300 miles, with a total expense of energy less than one horse-power, by the Lodge-Muirhead system without earth connections. Fessenden has made communication between Brant Rock and Cape Saint Roc, Jamaica, a distance of 3,000 miles, both by day and by night, using waves of a frequency of 80,000 periods per second.

The Marconi service is operated in favorable conditions between Glace Bay, Newfoundland, and Clifden, Ireland, with a frequency of 70,000. The messages are commonly received also at Brant Rock and the Eiffel Tower.

Poulsen, with an antenna suspended from a mast 92 feet high, has received messages from a distance of 1,370 miles with a power of 5 kilowatts.

The Marconi transatlantic service is not yet absolutely regular, but the service of the Eiffel Tower may be cited as a model. Communication is made without fail from the Eiffel Tower to the stations on the coast of Morocco. The warship "Kléber," cruising in the Mediterranean, has also communicated with the Eiffel station, with a power of 5 kilowatts.

In wireless telephony the following results have been obtained:

Fessenden in 1906 established communication between Brant Rock and a schooner 11 miles distant. Soon afterward he established communication between Brant Rock and Cape Saint Roc. According to Fessenden, the frequency should be at least 25,000.

The Poulsen system has given complete satisfaction in communicating between Copenhagen and Jutland, a distance of 175 miles, and even between Copenhagen and Berlin, a distance of 270 miles, with 6 kilowatts. The De Forest system, which is substantially identical with the Poulsen and the Stone, has been installed since 1907 on thirty American vessels, and has recently given excellent results in France. The United States navy has decided to extend the employment of wireless telephony.

The Telefunken process has been operated successfully between Nauen and Berlin. Very satisfactory communication has been established between Paris and Melun by Colin and Jeance. The Clark system has operated over 25 miles. Majorana, with his special microphone and a Poulsen arc oscillator, has attained successively 38, 75, 125, and 310 miles.

Finally, I will merely mention the experiments of Berjonneau-Knudsen and Rieder in the wireless transmission of photographs.

The foregoing is a summary of the present condition of wireless telegraphy and telephony. It is evident that enormous progress has been made in fourteen years (since 1895). The problem is not yet completely and commercially solved. The difficulties of interference and of secrecy of correspondence still remain. It has been found recently, in many instances, that messages sent from powerful stations can easily be intercepted, without special apparatus and even without an antenna. But everything takes time, and it cannot be doubted that wireless telegraphy and telephony will one day be perfected.—Translated for SCIENTIFIC AMERICAN SUPPLEMENT from Revue Generale des Sciences Pures et Appliqués.

A NEW RADIO-THERAPEUTIC PROCESS.

A SHORT time after the discovery of the radio-activity of radium, it occurred to some to study its effects upon diseased organisms. It was not long before the potential curative effect which these radiations possess was revealed, especially as regards certain affections of the skin. There was therefore adopted in medical practice not only the direct actions of radium itself, but also of those of its gaseous product, the emanation. It was found, moreover, that a number of mineral waters contained large quantities of this emanation, and that as a result of the invisible rays emitted by them, they were able to act upon all bodies placed in proximity thereto. Convinced by this that the curative effects of these waters was due entirely to their content of radium emanation, many chemical manufacturers have made plans for the production of medical compounds containing this emanation.

Cosmos states that recently Dr. A. Fürstenberg has treated by radium emanations more than one hundred persons affected by many diverse diseases, administering to them water to which emanations had been artificially added, and both in the form of beverages and of baths. It was of course necessary to carefully regulate the dosage, in order to safeguard the body against serious damage.

It was remarkable that in most of these cures there was manifested a phenomenon which has long been familiar to visitors at practically all mineral springs: some days after commencing the treatment, the patient began quite suddenly to be affected with pains, located generally in a part of the body which was identical with the seat of the original trouble. It was held, now, that far from indicating failure, this phenomenon should be considered as an indication of the attainment of the cure. In a similar manner, in the artificial treatment by the emanations, this reaction, it seems, may be relied upon as an indication of improvement or of a definite cure.

These investigations have given other very interesting results, for example, by proving absolutely that internal treatment was very much more preferable than treatment by bathing. The author does not hesitate to affirm, also, that any success attained by treatment by bathing was due entirely to the quantity of emanation inhaled, since the latter is quite incapable of penetrating healthy skin. Because of this fact, the author declares in favor of the employment, in certain diseases, of inhalations of the emanations.

Although this treatment is far from constituting a panacea, it gives truly surprising results in certain affections, particularly gout and rheumatism. Nervous troubles, on the other hand, have small chance of profiting by this mode of treatment.

The new transcontinental railway across the lower part of the North American continent, which connects the port of Tampico on the Atlantic with the port of Manzanillo on the Pacific, was to have been 1,031 miles in length, but the government has decided to build a cut-off between Guadalajara and Aguascalientes, which will reduce the route across the continent to about 800 miles.

DEMONSTRATIONS WITH THE MUSICAL ARC.

PROOF OF ELECTROMAGNETIC THEORIES.

BY W. B. HUFF.

THE musical arc offers a convenient means of demonstrating many important features of electro-magnetic theory. It may be of interest, therefore, to give a brief description of apparatus and methods, with references to some of the more elementary experiments which have been found helpful.

As is well known, the musical or "singing" arc* is obtained by connecting in parallel with the direct current arc a system containing self-induction and capacity. The arc used without this parallel or "secondary" system may be more or less unsteady, showing at the poles sudden change of potential difference of considerable magnitude. The secondary system may be thought of as supplying the conditions for taking up these fluctuations, and, in turn, emitting electric oscillations of frequencies determined in large part by the secondary itself. These oscillations, reacting on the arc, cause fairly regular interruptions in the discharge, which therefore emits a musical note. The pitch of this note may be varied by changing the conditions of the arc-circuit as well as by varying those of the secondary.

Examination by a revolving mirror and by the spectroscope seems to confirm what might from general considerations be expected in an arc of this kind, viz., that although the arc is interrupted, the poles give the distinctly different and characteristic forms of discharge observed in the continuous arc.†

For purposes of demonstration, good results may be obtained by using a condenser with capacity which may be varied from 1 to 10 microfarads and which is capable of standing a potential difference of 1,000 volts. The coil for the secondary may be made with three hundred turns of No. 15 annunciator wire wound on a spool of 10 centimeters radius and 3 centimeters axial length. The arc is perhaps most easily maintained between carbon poles. Examined in a revolving mirror, the musical arc shows serrations which are strongly marked near that pole which would be positive for the uninterrupted arc. Therefore to minimize the effects of convection as well as those due to wandering of the discharge over the terminals, and consequent change of pitch of the note, the poles should be about 8 millimeters in diameter, vertical, and the positive one below.

With the above apparatus, the arc, after burning until the positive pole is sufficiently coned, may be made to give a clear note of tolerably uniform pitch and audible throughout a fairly large room.

Both pitch and intensity depend not only upon capacity, self-induction and resistance in the secondary, but also upon the potential difference of the arc terminals. High potentials give clearer tones, but the 110-volt circuit answers very well. For a given secondary, a slight adjustment of arc-length or of resistance in the arc-circuit may make a striking difference in the clearness and intensity of the note. Using the 110 V.D.C. mains, a current of 1.5 to 2.5 amperes is necessary. Too much current produces a hissing or an impure note, or even none at all. The fact that the tones may not be pure* does not interfere seriously with their use qualitatively as indicators of changes made in the various circuits employed. All connections should be very firmly made.

To show induced currents, incandescent bulbs may be used to advantage. Those of small resistance and for small potential difference are better, though of course easily burned out. Add to the above apparatus a few coils of various sizes, some metal plates, etc., and interesting demonstrations become at once possible. They depend on the change of pitch of the arc-note, or on the lighting up of incandescent lamps; these effects arising from modifications of the electrical conditions of secondary or tertiary circuits.

An obvious experiment is to vary the note by changes in the secondary, several octaves being easily obtained. This makes possible rough comparisons of self-inductions and of capacities for oscillatory currents, by comparing the arc-tones with those from tuning forks. The use of the ordinary formula, $2\pi\sqrt{LC}$ for the period of the discharge involves the assumption of its applicability, as well as the further one that the resistance may be neglected. It may readily be demonstrated that the latter is only approximately true.

The short-circuiting of the coil in the secondary produces a note the shrillness of which gives an instructive idea of the part played by inertia in an oscillating electrical system. An incandescent lamp may be made to light up by joining it with a coil laid on the one in the secondary circuit. Rotating and sliding the upper coil are modifications that suggest themselves at once. For oscillations of very high frequency, the bulb will not light up, since the heating effect varies inversely as the frequency, if the latter is high and the resistance is negligible. Placing a coil in open circuit on the one in the secondary produces no effect; but the result of closing the circuit of the upper coil is to raise the pitch of the note, the increased frequency of the oscillations arising from the decrease in effective self-induction in the oscillating system.

It is instructive to close the upper coil alternately through each of two equal resistances, one of which is non-inductive. The difference of pitch may be made very striking.

If two coils are used in series in the secondary, the effective loading of the oscillating circuit depends on the position of one coil relative to that of the other. The maximum inductance, and consequently the lowest note, is obtained when one coil lies upon the other so that the directions of their fields are the same. This contrasts sharply with the high note emitted when the fields oppose.

An iron plate laid on the coil in the secondary increases the inertia of the system and consequently lowers the pitch of the tone. In this way it may be shown that a soft iron plate changes the arc-tone more than a steel plate of equal thickness does. A plate of non-magnetic metal raises the pitch. Such a plate may be regarded as a series of closed conductors. Interesting results may be brought out by comparing the effects of using solid metal plates and similar plates cut into sectors, insulated from one another. These results suggest the use of different forms of cores in a solenoid placed in series with the secondary circuit, or with the lamp and coil used to show induced currents.

The screening effects of conducting plates may be shown by placing them between the secondary coil and another coil in circuit with a lamp. For high frequencies, thin sheets of copper or of iron may cut down the brilliancy of the bulb very decidedly.

If a short-circuited coil is used instead of the plate, a similar screening effect may be shown.*

To show "resonance," arrange a second oscillating system containing capacity, self-induction, and a small lamp. If the coil of one system is laid upon that of the other, and the natural periods of the two systems are made approximately the same, the bulb lights up and the pitch of the note is changed. There is a considerable range of response in the second system, but with proper adjustment a maximum of light for varying frequencies may easily be observed. The use of two coils in series in this second oscillating system is convenient. One below the secondary coil and the other sliding on top of it makes the adjustment for maximum effect easier. The reaction of this new oscillating system on the secondary and thus on the arc may be very interestingly shown by making and breaking the new oscillating circuit while changing the capacity in the secondary circuit and noting the resulting change of pitch of the arc-note. The direction of this change depends on which of the two free periods is the greater.†

In conclusion it should be said that the above suggestions are made merely to call further attention to a means of demonstration which in some respects is simpler than the spark-discharge, and which has certain advantages over models.—Science.

Bryn Mawr College.

* Duddell, Electrician, 46, 1900. Simon, Phys., Zeit., vii., 1906. Austin, Bulletin of Bureau of Standards, 3, No. 2, 1907.

† Vide Astrophysical Journal, xxviii., No. 1, 1908.

* Austin, loc. cit.

* Cf. J. J. Thomson, "Recent Researches," § 427.

† J. J. Thomson, "Recent Researches," § 432.

AUTOMORS, A NEW DISINFECTANT.

By DR. P. FLEMMING.

A NEW disinfectant has recently been widely advertised in Germany under the name "automors." In a pharmaceutical journal the manufacturers of the preparation describe it as a combination of cresol with acids. Two specimens which were purchased and analyzed by Dr. Noerdlinger contained different proportions of phenol, phenol sulphuric acid and free sulphuric acid. A specimen analyzed by Dr. Mueller yielded 1 per cent of hydrocarbons, 2.5 per cent of phenol, 0.85 per cent of amines, about 15.5 per cent of cresol sulphuric acid, 17.5 per cent of free sulphuric acid, and a little sulphurous acid. According to Dr. Herold's investigations, automors is a mobile dark brown liquid, with a faint odor of sulphur dioxide and oil of tar, and a specific gravity of 1.2, containing about 15.4 per cent of free sulphuric acid, 11.4 per cent of sulpho acids, 50 per cent of water, small quantities of ash, resin, and hydrocarbons, and traces of sulphurous acid.

These analyses show that automors is not a substance of uniform composition and indicate that it is made by heating variable mixtures of sulphuric acid and crude cresol containing a large proportion of tar, for it leaves a sticky deposit on all vessels in which it has stood and does not form a clear solution with water, although crude cresol containing 10 per cent of impurities, treated with the proper quantity of sulphuric acid, dissolves completely in water.

What, then, is new in this preparation? Mixtures of crude cresol and sulphuric acid have long been employed for disinfecting abattoirs, cattle cars, etc. A preparation called "sanatol," which is apparently nearly identical with "automors," has been on the market ten years.

Automors is advertised as non-poisonous, but experiments made at the writer's request have proved that it is very poisonous to rabbits and guinea pigs. The mortal dose for a guinea pig is less than 5 cubic centimeters injected under the skin or less than 1/10 cubic centimeter introduced into the peritoneum. With rabbits the minimum fatal dose is 1.4 cubic centimeter injected under the skin or 4 cubic centimeters introduced into the peritoneum for each kilogramme of the animal's weight. Rabbits were not seriously affected by swallowing doses of 2 or 3 cubic centimeters mixed with fifty times their volume of milk, but these are very dilute solutions and the poisonous and corrosive action of phenols and sulphuric acid is prevented by the presence of milk. Strong aqueous solutions (1 to 4) proved fatal, and the stomachs of the animals were found greatly corroded and perforated in many places.

Another series of experiments was made to test the claim that automors possesses five times the disinfecting power of carbolic acid. It was found that a 1 per cent solution of automors exerted a smaller germicidal effect upon staphylococci in bouillon than a ½ per cent solution of carbolic acid. Similar results were obtained with the bacilli of splenic fever.

Dr. Schneider obtained somewhat better results, but he also found automors less effective than carbolic acid in destroying both staphylococci and the bacillus coli, cultivated in bouillon. In "physiological salt solution," on the other hand, automors actually proved five times as efficient as carbolic acid, but it is not allowable to base a general claim on specially favorable conditions which never occur in practice. Furthermore, it is probable that the effectiveness of automors would be destroyed by the presence of alkalies, alkaline carbonates and borates, salts of other weak inorganic acids and almost any organic salt in excess, for the only active ingredients of automors are free sulphuric and sulpho acids, and when these are neutralized the preparation becomes inert. In particular, the disinfecting power of automors would be destroyed by soap.

The further claim that automors will drive away flies has been disproved by Dr. Kirstein.

In short, automors is a poisonous mixture of sulphuric and cresol sulphuric acids and a less powerful germicide than carbolic acid. It is not even new, but is an old preparation bearing a new name.—Zeit. f. ang. Chemie.

THE FEAR OF WATER.

IT is well known that water is blamed, not without reason, with being the means of transmitting a great number of infectious maladies, notably typhoid fever and cholera. It is generally admitted, also, that the contagions are produced by the drinking of contaminated water. Those who are prudent do not fail, therefore, to boil water which is to be used for alimentary purposes.

Dr. Remlingen raises now, in the name of hygiene, still another and new cry of alarm.

If water is sometimes dangerous for internal uses, it is sometimes, also, for external uses.

It develops that boatmen, working around and on infested water, have been contaminated without drink-

ing it, simply by contact with spray, which without doubt has caused their illness.

River baths, even sea baths themselves, are able to present such dangers when the water is not very clean, dangers moreover which are more immediate, in that one is always exposed to the swallowing, either voluntarily or accidentally, of drafts of the water.

As to bathing in pools, it is unnecessary to insist upon the disastrous risks to which one is thus exposed. The conclusion must be that it is necessary to wash the hands and body with water which has been boiled, never even allowing the hands to remain in water which is questionable, or still more, taking a bath in water of such a nature.

We cannot refrain, as the result of this, from raising a question: If we are exposed to such terrible risks by bathing, would it not be much more hygienic not to bathe at all? It appears that these considerations cannot but augment greatly the number of those persons who do not bathe except when they are caught in a shower!

Let us admit that water is sometimes anti-hygienic; but agree that hygienists (?) go to excesses in always beclouding man's safety.—Cosmos.

ON BOARD THE "PARSEVAL."

A TRIP IN THE FAMOUS MILITARY DIRIGIBLE.

BY ROBERT SAUDEK.

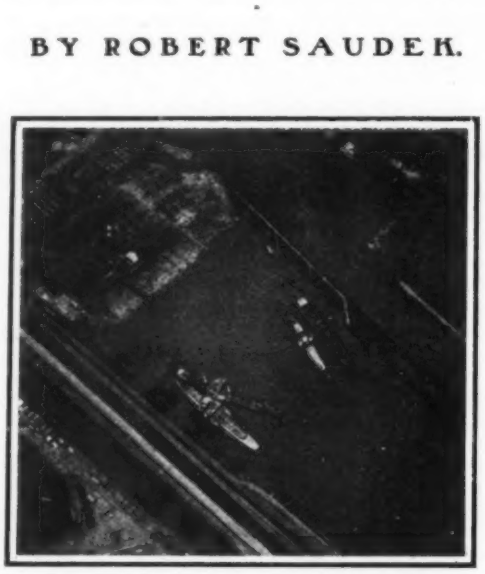
CONTINUED rainy weather and violent winds have long kept the new airship "Parseval III." a prisoner in its hall. The airship accommodated ten persons. Two of those Americans who are always on hand when anything up-to-date is going on, had to be turned away, as it was found that to take two extra passengers would necessitate the sacrifice of too much water ballast.

Shortly after 5 o'clock the "Parseval" rose in the air, under the impulsion of its twin screws, moving upward at a gradually increasing grade against the fresh breeze. The vessel turned and twice crossed the grounds of the IIa Exhibition, continually rising to higher levels.

For a novice in aeronautics, such a first ascension was certainly somewhat disillusioning. The expected sensation was lacking. We rose softly and quietly, with a feeling of perfect safety which destroyed the impression of doing anything unusual. All great things are disappointing at our first experience of them. All of us had already enjoyed bird's eye views from the summits of lofty mountains, and the easy, apparently motionless ascent of the airship deprived us even of the excitement of impending danger. But the expected surprises came when we had ascended to a still higher level, and left the houses of Frankfort behind us.

Distance lends enchantment to the view. A section of the city filled with workmen's dwellings, monotonously alike, appears, when seen from the clouds, like a dainty group of toy houses. A forest of lofty old trees resembles a thick and peculiarly woven carpet upon which a pretty pattern is traced by scattered red house roofs. A quantity of linen, hung out to dry on the banks of the Main, suggests a flower bed, and the long rows of gray headstones in the cemetery very strangely appear like glass beads of various colors. On the other hand, the crowds of human beings dressed in bright-colored summer clothing, among whom we had been moving a short time before, produces the impression of short black marks, each crowned by a white point. It is quite impossible for us to detect any differences in form and color, and all these human beings seem to be running hither and thither with the apparent aimlessness of ants.

We have now reached the height which our pilot, the well-known and expert aeronaut, Lieut. Stelling, desired to attain. We move on rapidly in a horizontal course under the guidance of the helmsman. Then we sink by degrees. With surprise we observe that we are now at the level of the captive balloon of the IIa Exhibition, which had hitherto been several hundred yards below us, and we now first appreciate the height to which we had ascended. To our inexperienced eyes, every measure of distance is lacking at these elevations, for we are accustomed to regard only horizontal surfaces.



A BIRD'S EYE VIEW OF THE RHINE BASIN.

The goal of our flight is now attained. The canvas sails of the propellers hang limp for a time, and then begin to turn again. Our commander springs forward and cuts the cord which holds the landing rope. We sink with bewildering speed and find the crew of the aeronautic society standing ready to draw us safely down to earth.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Ueber Land und Meer.

ENGINE POWER FROM SOLAR HEAT.

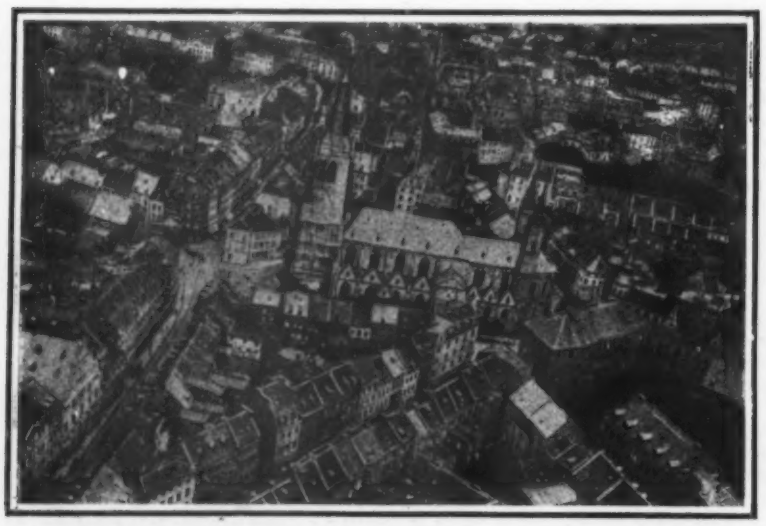
IN an interesting article, published in Engineering News, H. E. Willsie first reviews the various attempts—many ridiculous and some otherwise—which have been made toward the solution of the problem of the conversion of the solar heat available at the earth's surface into mechanical power. The experimental work of Mr. Willsie and J. Boyle, Jr., is then described at considerable length. The principle adopted is that of "indirect storage." Thus the intermittent solar heat is absorbed and collected by water circulating under the glass of the "heater." The water so heated is stored in a tank, well insulated to reduce the loss by radiation. The heated water is drawn uniformly and continuously from the storage tank and made to give up its heat by circulating it about a boiler containing SO_2. The vapor generated by this heat, after operating an engine, is condensed and returned to the boiler to be used again, while the water which has given up its heat to the SO_2 is sent through the solar "heater" again to collect more heat from the sun's rays. It is found that on parallel 34 deg. about 2,300 British thermal units per square foot will be taken up by the water during a June day and about 1,600 British thermal units during a December day. The experiments finally led up to a 20-horse-power sulphur dioxide engine being used, which at times, with a boiler pressure of 215 pounds per square inch developed about 15 horse-power. Two heater sections exposing an area of 1,000 square feet to the sun (each square foot absorbs about 377 British thermal units per hour) and a condenser were used, the water for which latter was pumped by the engine from a well. The following figures, based upon Josse's data, are given as to cost of a solar power plant:

Heater, 24-hour size, per horse-power	$100.00
Storage, 100-hour size, per horse-power	10.00
Engine, pumps, etc., per horse-power	20.00
Vaporizer, per horse-power	15.00
Condenser, per horse-power	15.00
Liquid sulphur dioxide	1.25
Emergency steam boiler	2.75
	$164.00

A comparison of estimated costs (on the basis of the experiments) per horse-power-hour with steam and solar-electric plants of 400 horse-power is given below:

Cost of one electric horse-power-hour, cents.	Steam.	Solar.
Engineer, 40 cents per hour	0.08	0.08
Fireman, 30 cents per hour	0.06	——
Dynamo man, 40 cents per hour	0.08	0.0[illegible]
Helper, 25 cents per hour	0.05	0.05
Superintendence	0.06	0.06
Coal	1.5	——
Interest, maintenance, depreciation power plant	0.046	0.184
Interest, maintenance, depreciation electric plant	0.006	0.006
Oil, waste, water (or sulphur dioxide)	0.15	0.15
Total, estimating steam plant at $40 per horse-power	2.032 cents	
Total, estimating solar plant at $164 per horse-power		0.610 ct.

From these figures it is clear that to compete with a sun power plant (which of course would only be employed in suitable regions, such as in California, where the authors carried out their experiments) a steam plant would have to obtain its coal for 66 cents per ton, or a producer-gas engine for about $2 per ton.



COLOGNE, SEEN FROM THE "PARSEVAL."

A VIEW OF THE TYROLESE MOUNTAINS FROM A DIRIGIBLE BALLOON.

ON BOARD THE "PARSEVAL."

MACHINE-PICKED VS. HAND-PICKED HOPS.

A REVOLUTION IN THE HOP INDUSTRY.

THE recent invention of hop-picking machines by E. Clemens Horst will have a marked effect on the hop industry.

Long ago hop growers dreamed of the day when hops would be picked by machines, and thus solve the problem of the hop grower's "picking time." Many attempts have been made to produce a picking machine, as shown by the large number of applications for patents filed with the United States Patent Office, but as no one succeeded commercially, the idea of inventing a picking machine was abandoned and given up as a rainbow-chasing proposition.

Hops ripen rapidly and should be picked at the proper time, otherwise they soon pass their prime and depreciate in quality. Therefore, the time of picking is of the utmost importance. Under the old method of hand picking, the hop growers were entirely dependent on labor, and were kept constantly in dread of not being able to secure the necessary amount of help at the right time to pick their crops.

Labor conditions instead of improving grew worse, until they reached such a state that it was necessary for the large growers to either reduce their acreage or invent some other cheaper method of harvesting. This condition had the effect of Mr. Horst's inventing his hop-picking machine. We have now solved this problem, and can convince the most skeptical that one of our machines can do the work of 450 hand pickers.

A Horst hop-picking machine with two men picks one hundred pounds of green hops per minute, or six thousand pounds per hour, and picks them absolutely clean and much better than human beings and at a big saving to the grower.

The worry on account of scarcity of labor is eliminated, and the consumer is assured of receiving hops vastly superior in quality over hand-picked hops, for the reason that the grower can pick his hops in any part of the field as they may become ripe and just right for picking. With hand pickers he is compelled to pick his fields straight through as they are. The result is that some of the hops are unripe, while others are ripe and over-ripe, and as they are all mixed in together and dried on the same drying floor, one can readily understand why hand-picked hops are not of uniform quality. Another serious objection to hand picking is the great damage that results to hand-picked hops from lying in boxes or sacks from six to twelve hours until the drying begins.

Pickers usually begin work at 5 o'clock in the morning, and the hops they pick are not put on the drying floors until noon and sometimes as late as 6 o'clock. Those picked in the afternoon often do not reach the drying floors until the next morning. While the hops are packed in sacks or boxes in the meantime, the 75 per cent of water in the undried hops causes them to sweat, discolor, and damage to such an extent that sulphur is freely used to hide the damage. With the machines this objection is done away with; for the picked hops instead of being delayed are landed on the drying floors within two or three minutes from the time the vines are fed into the picking machine.

The machine is about fifty feet long, fifteen feet high, and ten feet wide. The vines are hauled from the fields and fed in at end of the machine and travel over revolving picking drums the length of the machine and then return over a second set of the similar drums, at the end of which the vines are discharged free of hops. The drums are equipped with V-shaped

LOADING HOP VINES FOR THE PICKING MACHINES.

fingers, which pick the hops as the vines travel over the drums. These fingers are so made and adjusted that they pick the hops directly at the end of the hop and without the stem that is usually left on by hand picking. The finger construction and adjustment is also made so that most of the leaves are left on the vines, but to guarantee clean picking all the hops go through two separating processes. The upward-traveling belt running the full length of the machine receives the hops and leaves from the machine. The hops being round roll down into the conveyer, which carries them to the second separating process, while the leaves on account of being light and flat stick to the belt and are delivered into another conveyer. This part of the mechanism is particularly interesting.

The second process carries the hops from the conveyer into which they roll from the belt to and through a perforated cylinder through which the hops drop. Leaves that have not been taken out by the previous process are here automatically picked out.

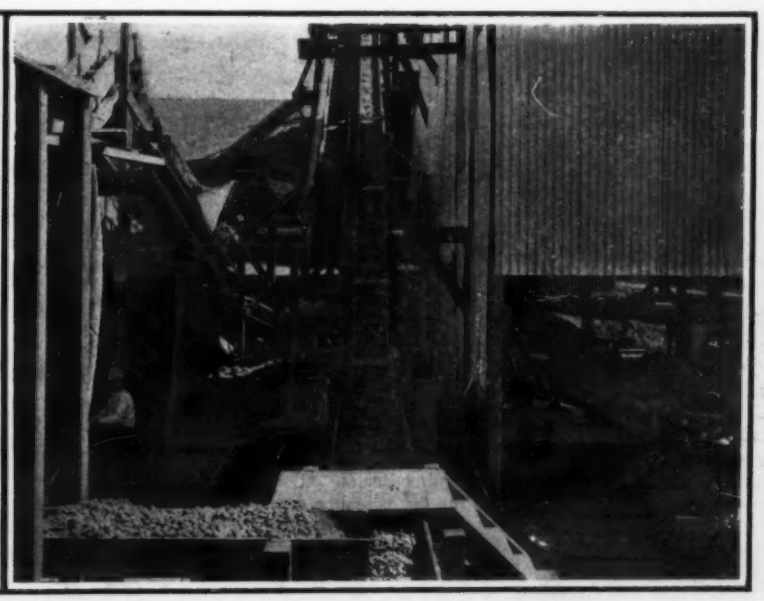
The world's hop consumption is about 1,100,000 American bales per year, the picking of which costs approximately $7,000,000 per year. The machines' benefit to the industry by saving in cost and improvement in the quality of hops is readily seen. Moving pictures of the hop-picking machines are to be put on exhibition in all the important brewing and hop centers throughout the world, and will be found of great interest.

FUSED WOOD.

WHEN wood is heated in an indifferent atmosphere, and to a temperature which is relatively somewhat high, there occurs a fusion, and isolated fragments are able to agglomerate one with another. For a long time fused wood, so obtained, has been only a laboratory curiosity which Messrs. Bezonnard and Lenoir obtained in 1891, without special arrangements, when they produced specimens in a closed vessel without very intense heat.

These first results gave a hint to some inventors, and there now actually exists a technical process which is well worked out, and which permits the manufacture of fused wood. The price of the product, for some reason, is still very high. An autoclave with a double bottom, in which circulates superheated steam, is filled with fragments of wood. The lid of the autoclave is provided with a tubulature and a cock, by means of which it may be placed in communication with a tank

SIDE VIEW OF HOP-PICKING MACHINE, SHOWING DISCHARGE OF CLEAN-PICKED HOPS AT THE RATE OF 100 POUNDS A MINUTE. THE HOPS ARE CLEANER THAN IT IS POSSIBLE TO PICK THEM BY HAND.



CONVEYER CARRYING THE PICKED HOPS FROM THE HOP-PICKING MACHINES TO THE HOP-DRYING FLOORS.

MACHINE-PICKED VS. HAND-PICKED HOPS.

of water. The receiver is then emptied, and the autoclave heated to about 140 deg. As the water and the substances contained in the wood are evolved, evacuation is continued with the aid of the tank. The heating is continued for about three hours. The pyrogenous products separate from the mass during this period, and are pumped out by the aid of the tank, and then collected in a condenser.

There remains then in the autoclave nothing except the fibrous skeleton of the wood, and the mineral salts, which exist in the form of a fused mass. This is allowed to cool slowly, always with the exclusion of air. The product is next transported to a second autoclave, the interior of which is also evacuated. The air removed is replaced by nitrogen, under a pressure of about two atmospheres. The apparatus is then heated to 800 deg. for about two hours. The wood is quickly melted and transformed, after cooling, into a homogeneous and tough mass. For this procedure, which is long and costly, it is well perhaps to substitute another which is much simpler, but which on the other hand presents the serious defect of not permitting the recovery of any valuable by-products, but of allowing to escape at an entire loss all of the products of the pyrogenous distillation of the wood.

There are introduced into an autoclave fragments of wood or sawdust. A vacuum is then created, and the air replaced by nitrogen at a pressure of two atmospheres, whereupon the interior is heated to a temperature of 900 deg. for two hours. There is thus obtained a compact mass consisting of a solid amorphous body having a very fine grain, which may be given a very high polish, and which is very tough and very resistant to abrasion.

The fused wood takes typographic ink well, and stands repeated washing with potash or carbonate of soda, or with turpentine. When it is poured into a mold in liquid state, it solidifies again on cooling, reproducing exactly all the small details of the mold. It has been possible to incorporate in the fused wood antiseptic substances, which will assure its preservation, it may well be said, indefinitely.

When the fused wood may be obtained economically, it is probable that it will find a considerable industrial use.—Inventions Illustrées.

EDUCATION BY EXPERIENCE.*

THE PHYSIOLOGICAL BASIS OF SUCCESS.

A GREAT step in the evolution of our race was the modification of the nervous system which should render possible the education of the individual. The mechanism for this educatability was supplied by the addition, to the controlling sensory ganglia of the head, of a mass of nervous matter which could act, so to speak, as an accessory circuit to the various reflex paths already existing in the original collection of nerve ganglia. This accessory circuit, or upper brain, comes to act as an organ of memory. Without it a child might, like the moth, be attracted by a candle flame and approach it with its hand. The injury ensuing on contact with the flame would inhibit the first movement and cause a drawing back of the hand. In the simple reflex mechanism there is no reason why the same series of events should not be repeated indefinitely, as in the case of the moth. The central nervous system, however, is so constituted that every passage of an impulse along any given channel makes it easier for subsequent impulses to follow the same path. In the new nerve center, which presents a derived circuit for all impulses traversing the lower centers, the response to the attractive impulse of the flame is succeeded immediately by the strong inhibitory impulses set up by the pain of the burn. Painful impressions are always predominant. Since they are harmful, the continued existence of the animal depends on the reaction caused by such impressions taking the precedence of and inhibiting all others. The effect therefore of such a painful experience on the new upper brain must far outweigh that of the previous impulse of attraction. The next time that a similar attractive impression is experienced, the derived impulse traversing the upper brain arouses, not the previous primary reaction, but the secondary one, viz., that determined by the painful impressions attending contact with the flame. As a result, the whole of the lower tracts, along which the primary reaction would have traveled, are blocked, and the reaction—now an educated one—consists in withdrawal from or avoidance of the formerly attractive object. The burnt child has learned to dread the fire.

The upper brain represents a nerve mechanism without distinct paths, or rather with numberless paths presenting at first equal resistance in the various directions. As a result of experience, definite tracts are laid down in this system, so that the individual has the advantage not only of his lower reflex machinery for reaction, but also of a machinery which with advance in life is adapted more and more to the environment in which he happens to be. This educable part of the nervous system—i. e., the one in which the direction of impulses depends on past experience and on habit—is represented in vertebrates by the cerebral hemispheres. From their first appearance they increase steadily in size as we ascend the animal scale, until in man they exceed by many times in bulk the whole of the rest of the nervous system.

We have thus, laid down automatically, increased power of foresight, founded on the Law of Uniformity. The candle flame injures the skin once when the finger is brought in contact with it. We assume that the same result will follow each time that this operation is repeated. This uniformity is also assumed in the growth of the central nervous system and furnishes the basis on which the nerve paths in the brain are laid down. The one act of injury which has followed the first trial of contact suffices in most cases to inhibit and to prevent any subsequent repetition of the act.

THE HORST HOP-PICKING MACHINE.

MACHINE-PICKED VS. HAND-PICKED HOPS.

THE FACULTY OF SPEECH.

If we consider for a moment the vastness and complexity of the stream of impressions which must be constantly pouring into the central nervous system from all the sense organs of the body, and the fact that, at any rate in the growing animal, every one of these impulses is, so to speak, stored in the upper brain, and affects the whole future behavior of the animal, even the millions of nerve cells and fibers which are to be found in the human nervous system would seem to be insufficient to carry out the task thrown upon them. Further development of the adaptive powers of the animal would probably have been rendered impossible by the very exigencies of space and nutrition, had it not been for the development of the power of speech. A word is a fairly simple motor act and produces a correspondingly simple sensory impression. Every word, however, is a shorthand expression of a vast sum of experience, and by using words as counters it becomes possible to increase enormously the power of the nervous system to deal with its own experience. Education now involves the learning of these counters and of their significance in sense experience; and the reactions of the highest animal, man, are for the most part carried out in response to words and are governed by past education of the experience-content involved in each word.

The power of speech was probably developed in the first place as a means of communication among primitive man living in groups or societies; as a means, that is to say, of procuring co-operation of different individuals in a task in which the survival of the whole race was involved. But it has attained still further significance. Without speech the individual can profit by his own experience and to a certain limited extent by the control exercised by the older and more experienced members of his tribe. As soon as experience can be symbolized in words, it can be dissociated from the individual and becomes a part of the common heritage of the race, so that the whole past experience of the race can be utilized in the education—i. e., the laying down of nerve tracts—in the individual himself. On the other hand, the community receives the advantage of the foresight possessed by any individual who happens to be endowed with a central nervous system which transcends that of his fellows in its powers of dealing with sense impressions or other symbols. The foresight thus acquired by the whole community must be of advantage to it and serve for its preservation. It is therefore natural that in the process of development and division of labor, which occur among the members of a community just as among the cell units composing an animal, a class of individuals should have been developed who are separated from the ordinary avocations, and are, or should be, maintained by the community, in order that they may apply their whole energies to the study of sequences of sense impressions. These are set into words which, as summary statements of sequence, are known to us as the Laws of Nature. These natural laws become the property of the whole community, become embodied by education into the nervous system of its individuals, and serve therefore as the experience which will determine the future behavior of its constituent units. This study of the sequence of phenomena is the office of Science. Through Science the whole race thus becomes endowed with a foresight which may extend far beyond contemporary events and may include in its horizon not only the individual life, but that of the race itself as of all races to come.

RISE IN TYPE DEPENDENT ON BRAIN.

Thus, in the evolution of the higher from the lower type, the physiological mechanisms, which have proved the decisive factors, can be summed up under the headings of integration, foresight, and control. In the process of integration we have not only a combination of units previously discrete, but also differentiation of structure and function among the units. They have lost, to a large extent, their previous independence of action and, indeed, power of independent action, the whole of their energies being now applied to fulfilling their part in the common work of the organism. At first bound together by but slight ties and capable in many cases of separating to form new cell colonies, they have finally arrived at a condition in which each one is absolutely dependent for its existence on its connection with the rest of the organism, and is also essential to the well-being of every other part of the organism.

This solidarity, this subjection of all selfish activity

* Abstract of a paper read before the British Association for the Advancement of Science.

to a common end, namely, preservation of the organism, could only be effected by a gradual increase in the control of all parts by one master tissue of the body, whose actions were determined by impulses arriving from sense organs which themselves were set into activity by coming events. We thus have with the rise in type a gradually rising scale in powers of foresight, in control by the central nervous system, and in the solidarity of the units of which the organism is composed.

In the struggle for existence the rise in type has depended therefore on the central nervous system and its servants. Rise in type implies increased range of adaptation, and we have seen that this increased range, from the very beginning of a nervous system, was bound up with the powers of this system. Whatever opinion we may finally arrive at with regard to the types of animals which we may claim as our ancestors on the line of descent, there can be no doubt that Gaskell is right in the fundamental idea which has guided his investigations into the origin of vertebrates. As he says, "the law for the whole animal kingdom is the same as for the individual. Success in this world depends upon brains." The work by this observer which has lately appeared sets forth in greater detail than I have been able to give you today the grounds on which this assertion is based, and furnishes one of the most noteworthy contributions to the principles of evolution during recent years.

We must not, however, give too restrictive or common a meaning to the expression "brains" used by Gaskell in the dictum quoted above. By this word we imply the whole reactive system of the animal. In the case of man, as of some other animals, his behavior depends not merely on his intellectual qualities or powers, to which the term "brain" is often in popular language confined, but on his position as a member of a group or society. His automatic activities in response to his ordinary environment, all those social acts which we ascribe in ourselves to our emotions or conscience, are determined by the existence of tracts in the higher parts of his brain, access to which has been opened by the ruthless method of natural selection, and which have been deepened and broadened under the influence of the pleasurable and painful impressions which are included in the process of education. All the higher development of man is bound up with his existence as a member of a community, and in trying to find out the factors which will determine the survival of any type of man, we must give our attention, not to the man, but to the tribe or community of which he is a member, and must try to find out what kind of behavior of the tribe will lead to its predominance in the struggle for existence.

EDMUND HALLEY.*

THE MAN WHO DISPELLED COMETARY SUPERSTITIONS.

BY J. E. GORE, M. R. I. A.

IN view of the return of Halley's comet, which has now been found by the telescope, some account of the great astronomer with whose name the comet is associated may prove of interest to the general reader.

The great French astronomer Lalande considered Halley to be the greatest English astronomer of his time, and this opinion is certainly just. He was doubtless one of the greatest men of science that England, or, indeed, any country, has ever produced.

Edmund Halley was born in London on November 8th, 1656. From his earliest year, he applied himself with zeal to the study of mathematics and astronomy, and obtaining such instruments as his means permitted he studied the heavens, and took advantage of every fine night to improve his knowledge of astronomy.

Knowing that a considerable amount of excellent work had been done on the solar system and among the stars of the northern hemisphere by Cassini, Flamsteed, and Hevelius, Halley thought it better not to enter into competition with these great observers, and decided to turn his attention to the southern stars of which no good observations had then been made. It was reported that a Dutch observer named Houtman had observed these stars in the island of Sumatra, and that Blaeu, the globe maker, had used these observations in the correction of his celestial globes. But Halley, on examining these corrections, came to an unfavorable opinion about the observer and his instruments. Having consulted with some of his friends on the best station to choose for his proposed observations of the southern stars, Halley decided on St. Helena. His father, a citizen of London, promised to supply him with the money necessary for the purpose. He was recommended to King Charles II. by Williamson and Jones Moore, and the Indian Company, who had control of the island, promised him all the assistance he required.

Having decided on the undertaking, Halley had a sextant of 5½ feet constructed, somewhat similar to that of Flamsteed, and he procured telescopes and micrometers. The largest of the telescopes was 24 feet in length. He sailed for St. Helena in November, 1676, at the early age of 20, and after a satisfactory voyage of three months he arrived at the island.

Although he had heard good accounts of the climate, it proved very disappointing. Frequent rains and a constantly hazy sky hardly permitted any observations in the months of August and September, and although he lost no opportunity for observation he found that at the end of the first year he had only observed some 360 stars.

Notwithstanding these difficulties he consoled himself with the idea that his labors would not be wholly in vain, and he connected the stars he observed with others whose positions had been determined by Tycho Brahé. His catalogue of southern stars, reduced to the epoch of 1677, was published in London in 1679.

In forming his catalogue he had necessarily to identify the stars he observed, and in this connection he made the following remarks with reference to stars in the constellation Sagittarius: "It may appear strange that the stars which are before the left hock and the knees (in the ancient figure of a centaur), which Ptolemy called bright and of the second magnitude, are at present of the fourth at most. This appears to show if not corruptibility, at least the changeability of the celestial bodies. This diminution of light may be attributed to some accident. It is probable that for a similar reason the stars of the left leg and right knee are now so small that Tycho overlooked them." Halley further remarks that some stars which Ptolemy placed before (that is, west of) Piscis Australis, and of which four are noted of the third magnitude, are at present only of the fifth or sixth, and he asks if this is due to the diminution of their light in the lapse of time.

In addition to his work on the stars, Halley made some investigations on the moon's parallax, combining his observations at St. Helena with those made in Europe. He also made some researches on the theory of the moon's motion, which was not thoroughly understood in his time, and which were so necessary for the determination of longitudes.

On November 7th, 1677, Halley observed a transit of Mercury across the disk of the sun. From his observations, which were not, however, obtained under favorable conditions, he derived a value of the sun's parallax of 45 min., which is, of course, much too large, the real value being about 8.8 min. But transits of Mercury are not suitable for measures of solar parallax, and, indeed, Halley pointed out that transits of Venus are much better for the purpose.

In 1679, Halley paid a visit to Hevelius to satisfy himself as to the accuracy of observation which the latter had claimed for his method of pinnules without the aid of a telescope. Halley convinced himself that the errors of the observations made by Hevelius were less than had been supposed, and did not exceed a minute of arc.

In the year 1684 Halley paid a visit to his friend, Sir Isaac Newton, to confer with him about the law of gravitation which had been previously discovered by Newton. The result of the consultation between these great men led to the publication of Newton's famous work, the "Principia." The first book of this immortal work was presented to the Royal Society of London in April, 1686, and ordered for publication in May of that year. But as the finances of the society would not admit of paying for the printing of the work the expense was generously defrayed by Halley. The "Principia" was published in 1687, and it is pleasant to know that Halley's expenses connected with its publication were afterward refunded by the sale of copies of the work.

Halley wrote a work on comets. Among former writers on the subject he found that the first account of a comet of any use for his purpose was one by Nicephorus Gregoras, who in the year 1337 recorded carefully the apparent path of a comet in the sky. But he was not so accurate in his record of time, and it was only on account of its having dated back by over 300 years that Halley included it in his catalogue of comets. The great comet of 1472, which made a near approach to the earth, was observed by Regiomontanus. This comet described an arc of 40 deg. in one day, and is the first of which satisfactory observations were made. The comet of 1577 was well observed by Tycho Brahé. Kepler observed two comets, and from their parallax he concluded that comets pass freely through the planetary orbits along a path which differs but little from a straight line. These views were supported by Hevelius, but Borelli seems to have thought that comets moved in elliptical or parabolic orbits round the sun, and this theory was confirmed by the great comet of 1680, which the observations of Halley and Newton showed to be moving in a curved path round the sun.

In his researches on the motions of comets, of which he computed the orbits of 24, Halley noticed that those recorded by Appian in 1531, by Kepler in 1607, and by Halley himself in 1682, seemed to return after a period of seventy-five or seventy-six years. He thus suspected that these comets were one and the same. This suspicion seemed to be confirmed by the recorded appearance of bright comets in the years 1456, 1380, and 1305, the intervals again being seventy-five or seventy-six years. He rightly conjectured that the comparatively small differences in the recorded intervals were due to the disturbing action of the larger planets. This was especially so when he found that in the year 1681 the comet passed near the planet Jupiter, the attraction of which must have had a considerable influence on the comet's motion. Making due allowance for this disturbing influence of Jupiter, he computed that the comet would return to the sun's vicinity about the end of 1758 or beginning of 1759. Halley did not live to see his prediction fulfilled (he died in 1742), but the comet returned, and, according to the calculations of Clairaut, its nearest approach to the sun was due on April 13th, 1759, with a possible error of one month.

The comet actually passed through perihelion on March 13th, 1759, only one month earlier than the date fixed by Clairaut! This showed the accuracy of Halley's foresight, and the comet has ever since been known by his name, although he was not its original discoverer. The comet again duly returned in 1835, and its next passage through perihelion will take place about April 20th, 1910. This is now certain, as the comet was found on a photographic plate taken by Dr. Max Wolf on the morning of September 12th of the present year, within a few minutes of arc of the position predicted by the calculations of Messrs. Cowell and Crommelin of the Greenwich Observatory—a great triumph for astronomy and mathematics.

In addition to his merits as an astronomer, Halley was a good navigator. In 1698 he obtained command of a vessel and voyaged in the Atlantic Ocean for the purpose of making observations on the laws which govern magnetic variation. He returned to England in June, 1699. His lieutenant, who had given him much trouble, was dismissed, and Halley continued his voyage. He reached 52 deg. of southern latitude, when the ice compelled him to turn back, and after some adventures he reached London on September 7th, 1700. He had another voyage in 1701 and 1702, and then retired from traveling.

In November, 1703, Halley succeeded Wallis as Savilian professor of geometry at Oxford. In 1713 he was elected secretary of the Royal Society, and in 1721 he succeeded Flamsteed as Astronomer Royal at Greenwich. He was then 64 years of age, but still full of zeal and energy. When Halley took charge of the Greenwich Observatory he found it almost devoid of instruments, Flamsteed's executors having removed all those which belonged to him. He obtained a meridian circle, similar to that of Roemer, which he used for four years to observe difference of right ascension. In 1725 a quadrant of 5 feet radius was set up in the meridian, and his efforts were chiefly directed toward the improvement of the lunar tables for the determination of the longitude at sea.

Halley observed the great aurora, which occurred on March 16th, 1715, and his accurate prediction of the total eclipse of the sun on May 2nd, 1715, added much to his reputation.

He died on January 14th, 1742, at the good old age of 85.

* Knowledge and Scientific News.

It has been suggested that painting steel sheets while they are hot would be of great advantage in preserving the metal.

MACHINES THAT MAKE CORDAGE.—I I.*

HOW VARIOUS FIBERS ARE MECHANICALLY FORMED INTO ROPE.

Concluded from Supplement No. 1769, page 346.

SPINNING YARNS.

THE next operation is to twist these slivers into the yarn on the spinning jennies. The degree of twist given to the material at any time during its progress is very important, because each individual yarn has its own twist and these again are twisted into the strands which in turn, each having its own particular twist, are again twisted into the final rope. Manila fiber is very strong in a lengthwise direction, but is quite brittle in a transverse direction. If then, a rope could be made up of Manila fiber as long as the rope itself, it would be stronger if it were not twisted; but as each fiber is comparatively short, the yarns and strands, and consequently the whole rope, are held together simply by the friction of the different fibers upon each other due to the degrees of twist pressing the different fibers against each other. The greater the twist the greater the friction between the parts, but as said, the more twist the less strength there is in each individual fiber, due to the peculiar nature of the Manila itself. Consequently in order to produce the best rope, the adjustment of the twists is a very particular thing to be taken care of and all the machines used in the manufacture of the strands and rope are provided with change gearing so that the various speeds and tensions may be accurately adjusted.

Fig. 8 shows a spinning room where the slivers, coming from the cans into which they were delivered by the finishers, are passed first through another series of traveling pins or combs and then through a conical tube where a certain amount of friction is applied to the sliver while the rotating part of the machine, which is shown on the right, twists these fibers into the yarn. After being twisted, the yarn is carried along the side bar of the revolving frame which reaches over the bobbin, as shown in the halftone, to a small pulley, which in turn leads the yarn to the bobbin. The frames and bobbins revolve at about 1,500 revolutions per minute, but the bobbins, of course, revolve slightly faster than the frames, or, as they are known, the fliers, because the yarn must be wound upon the bobbins as it is twisted.

Tension is put upon the yarn by means of two small pulleys or capstans, which are mounted on the face of the disk of the flier toward the middle of the machine. The purpose of the capstans is not only to give tension to the yarn, which is wound several times around each capstan, as they revolve on their own centers while revolving also with the flier itself, but also their traveling around the center line of the flier gives the twist to the yarn. At the same time that the yarn is being twisted and made, the bobbin is automatically caused to travel back and forth along the central spindle of the flier so that the yarn is wound uniformly over the length of the bobbin. This yarn resembles very coarse cord and in fact one use of this yarn which is familiar to almost everyone is for binding bundles of grain on automatic harvesting and binding machinery.

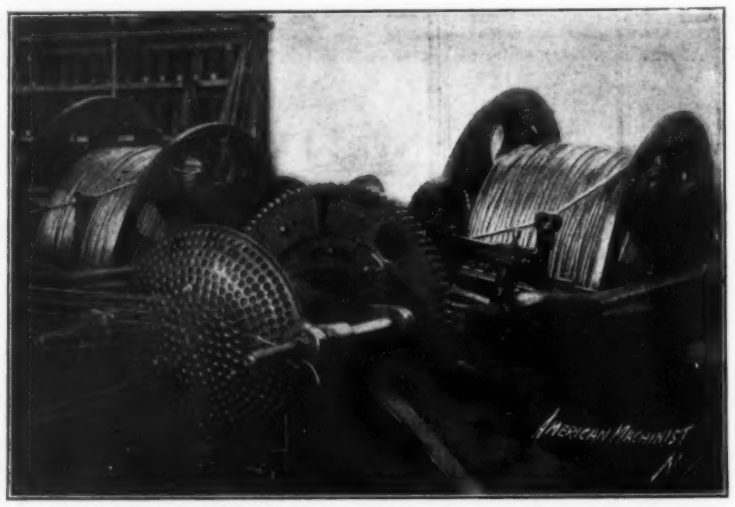


FIG 9.—A FORMER, TWISTING THE YARNS INTO A STRAND.

FIG. 10.—A ROPE LAYER TO FORM THREE STRANDS INTO A ROPE.

TWISTING THE STRANDS.

Yarn, being simply twisted fibers, is not very strong, and for the purpose of making rope must be further twisted into larger strands. Part of the operation of the making of the strand is illustrated in Fig. 9, which shows a former. Here it will be seen that a number of the yarns are passed in groups through a perforated plate. Back of this plate the different yarns are passed through a tube which forms the axis of the large gear wheel shown, and on the far side of this gear wheel one of a pair of capstans can be seen. The gear wheel, of course, revolves about the axis of the tube and by means of the small planetary gears shown in the halftone, the two capstans are also caused to revolve on their own centers at the same time that they are carried around with the main gear. The whole frame together with the large reel at the far end, as shown in the halftone, also revolves with the main gear and the capstans.

The effect of this rotation, of course, is to twist the different yarns into a strand, and the capstans take a strong grip on the strand which makes several revolutions around each capstan, thus supplying the requisite tension and at the same time giving it the twist

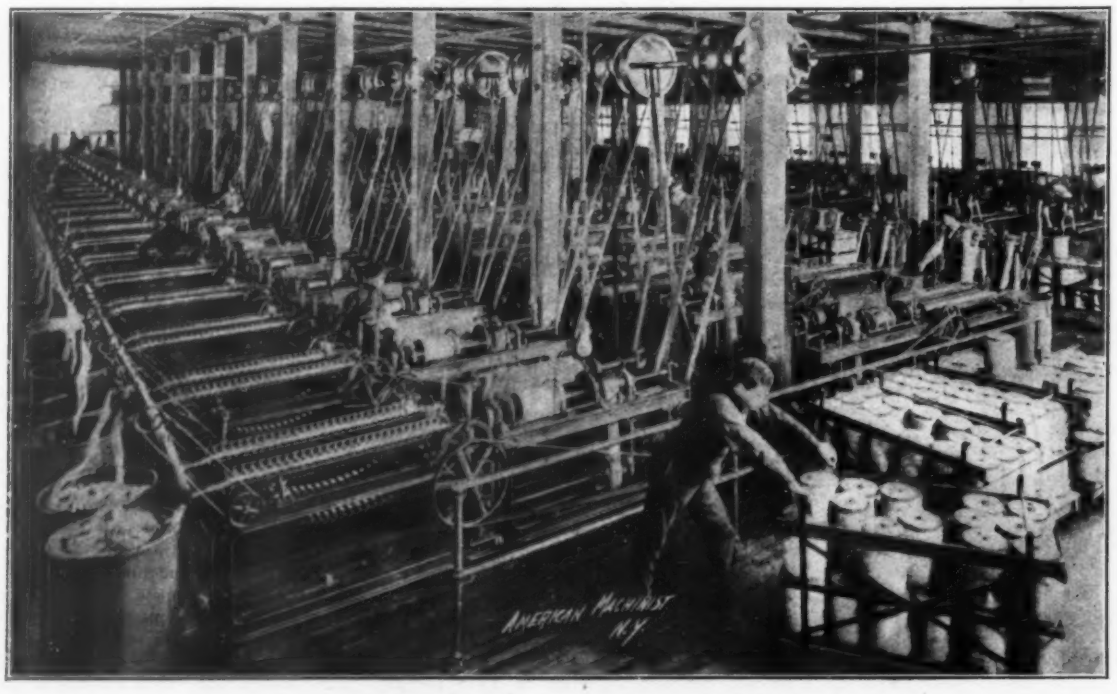


FIG. 8.—A SPINNING ROOM. MAKING THE YARNS.

* By courtesy of the American Machinist.

as the two capstans revolve with the main gear, around the center of the tube. It should be said that each one of the small yarns which goes to make up the strand is given an extra preliminary twist in its make-up, because in twisting these yarns into a strand a certain amount of this individual twist in the yarn is untwisted again, and this of course has to be compensated for.

LAYING THE ROPE.

When the strand has been completed and wound upon the reel, as shown in Fig. 9, these reels are taken from the forming machine and placed in the rope-laying machine shown in Fig. 10. In this view at the left-hand end will be seen three reels which have come from forming machines. Each one of these reels, when the machine is in operation, contains one of the strands which was made in the former. Each strand is led from its reels to a tube passing through the axis of the gear wheel shown in front of each one of the reels, and from this point they come down together to a grooved conical block which forms a guide to each of the three strands. After this they pass through a tube in the center of the axis of the main gear which, as it revolves, carries the frame and the two capstans, as shown in the center of the halftone.

The revolution of the central portion of the machine carries with it the yoke frame at the right-hand end, carrying the large reel. While each one of the small reels at the left-hand end of the machine revolves on its own axis, it also revolves on the axis of the frame carrying each reel, although the three reels do not revolve around each other. The action of these three reels will be clearly understood by referring again to the crude machine shown in Fig. 7. Each one of the hooks in Fig. 7 corresponds to a reel at the left-hand end of Fig. 10, and the reels revolve on axes parallel to the main axis of the machine, and at the same time by their revolving on their own axes allow the three strands to be drawn out and, as already described in connection with Fig. 7, twisted into a rope.

The two capstans shown in the center of Fig. 10 are again for the purpose of putting the proper tension on the rope and also to twist it about itself. After leaving the capstans the rope passes through the tube in the axis of the next gear wheel and finally through the traveling guide to the main reel at the right-hand end of the machine, this reel acting to coil up the finished rope as it is made. The object of the traveling guide on this frame is to wind the rope evenly back and forth along the axis of the reel.

A COMBINATION MACHINE.

Fig. 11 is an illustration of a combination former and layer. This machine, which makes ropes of 24 yarns or threads, the finished rope being from ⅜ to ½ inch in diameter, completes the operation of making the strands and the finished rope in one process. At the left end of Fig. 11 will be seen the 24 bobbins, each bobbin carrying a yarn. These bobbins are arranged in groups of eight, each group delivering eight yarns to be formed into one strand and the three strands into the finished rope.

Each of the three groups of eight bobbins is, of course, caused to rotate about the axis of the group. Necessary provision is made in the rotation of these various bobbins and groups of bobbins so that the yarn does not become either untwisted or overtwisted, and this is accomplished by means of the frames or fliers which surround the groups of bobbins, and in the halftone the strand coming from the bobbin is seen to traverse the outside of these frames or fliers, the revolution of which gives the proper twist to the strand.

In front of each group of bobbins forming a strand, the halftone shows a pair of capstans acting to give the correct tension and at the same time to twist the strand upon itself as already described. The three strands as seen are brought down to a funnel-shaped tube having the requisite guides directing each strand correctly, and the final twisted rope after passing through the traveling guide on the frame at the right-hand end of the machine is wound upon the reel there.

Fig. 12 is another machine of the same single process character with the exception that it is upright and suitable for larger rope, that is, from ⅞ to 1⅛ inches in diameter. In this halftone the bobbins are seen at the rear of the machine, although only one of the three groups can be seen. The three groups, as before, each form a strand, and these strands are twisted into the rope passing around the large capstan pulleys on the front of the machine to give the requisite tension and finally down to the large reel in the foreground.

From the various pictures it will be seen that numerous weighted levers are provided throughout the machines to act as friction brakes on the various rotating parts, and the adjustment of these weights together with the speeds of the various parts, as already said, form a very important part of the art of manufacturing rope by machinery. In no other industry is the old adage so true: "To make a wrong twist would untwist the whole twist."

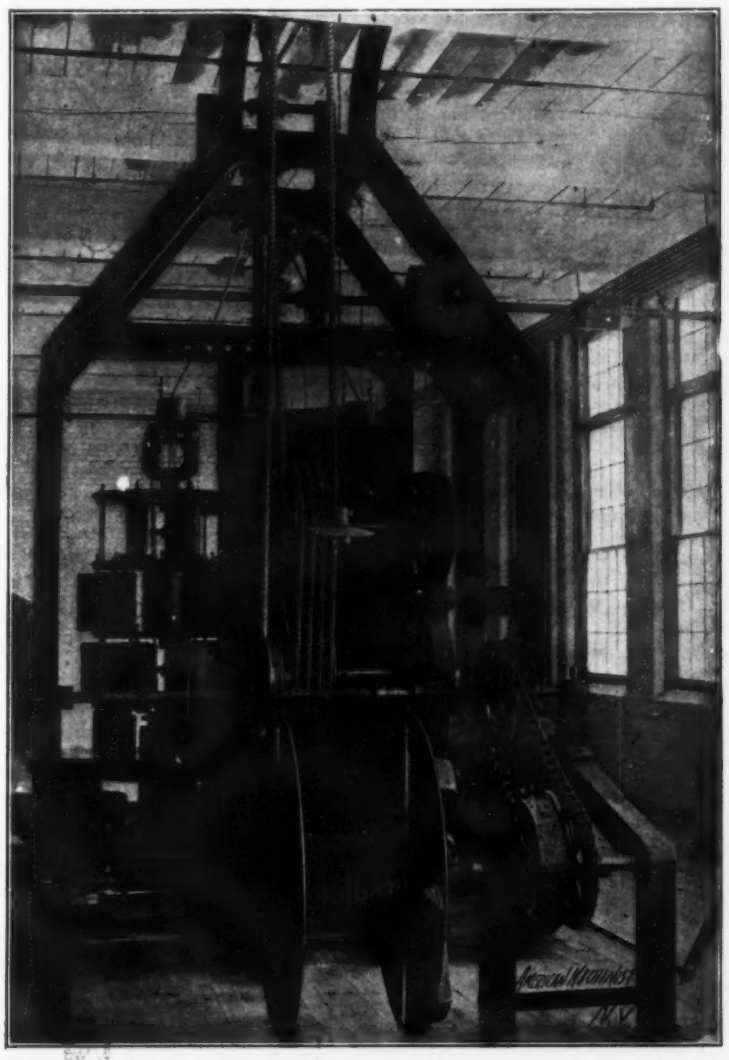


FIG. 12.—LARGE UPRIGHT ROPE MACHINE MAKING ROPE FROM THE YARNS IN ONE OPERATION.

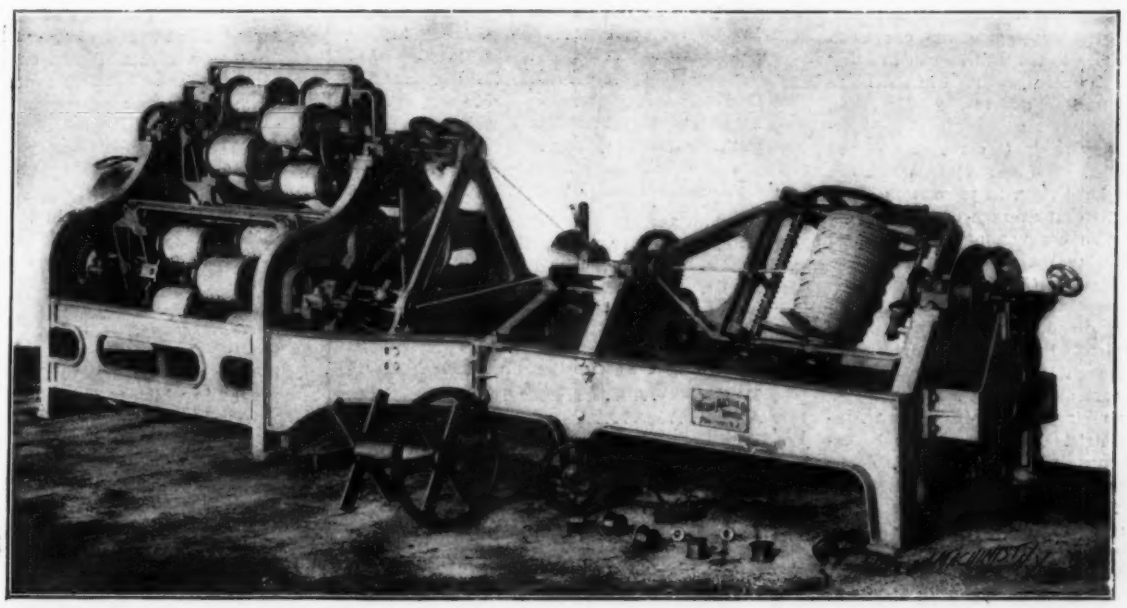


FIG. 11.—A ROPE MACHINE WHICH TWISTS 24 YARNS INTO THREE STRANDS AND THESE INTO A ROPE, IN ONE OPERATION.

The entire railway system of the State of Rio Grande do Sul, Brazil, with the exception of the Brazil Great Southern Railway, is now in the hands of Belgians, who are lessors of the lines, and are actively engaged in making important extensions. The number of miles in operation is about 690, and will soon be increased to 1,000. A connection is being formed with the São Paulo Railway, and has already made some progress from the other end.

ORGANIZING ZOOLOGY.*

THE TRUST SYSTEM APPLIED TO SCIENCE.

BY A. E. SHIPLEY, M. A.

WE live surrounded by a disappearing fauna. Species are disappearing from the globe at a greater rate than even the most ardent mutationist claims they are appearing. To mention but a few striking cases: The European beaver has almost gone, though a few linger on around the periphery of the continent. Norway, the lower Danube, Eastern and Arctic Russia still harbor them, and a very few are said still to inhabit the Rhine and the Rhone. The European bison is now represented by a few wild specimens in the Caucasus. The American bison is reduced, and that by the deliberate and calculated action of man, to a few herds most carefully preserved by government; the largest of these, containing some 600 head, is now at the National Park at Wainwright. Equally deliberate and equally calculated is the destruction of the fur-seal, which threatens soon to be complete. The Greenland sealing is almost a thing of the past. In 1860 British vessels killed 68,278 seals; in 1866, 103,778; and this went on until 1895, when the pursuit was abandoned by the British, it being no longer found to pay them, though Norwegians still contine "sealing." In 1859 19 vessels sailing from British ports killed 148 whales; in 1881 12 vessels killed 48 whales; last year 6 Dundee vessels killed but 15, and the year before that but 3. The whalers sailing from Newfoundland ports killed 1,275 whales in 1904, 892 in 1905, and only 429 in 1906.

At the present time certain Norwegian whaling companies have been for the last few years actively at work in the Shetlands, and are killing off as fast as they can the common rorqual (*Balænoptera musculus* L.), the lesser rorqual (*B. rostrata*), Sibbald's rorqual (*B. sibbaldi* Gray), the cachalot (*Physeter macrocephalus* L.), the humped-back whale (*Megaptera boops* L.), and, when they can reach him, the Atlantic right whale (*Balæna mysticetus* L.). These are killed primarily for their blubber, but the economy of the factories rivals that of the Chicago pork-packing industries. Nothing is wasted, the flesh is made into sausages, which are readily eaten in central Europe, and the bones are ground up to make manure. No animal which produces but few young can withstand such persistent and organized attacks on the part of man, and I fear, before many years have passed, many species of whale will be extinct. At the present moment the two right whales seem almost on the verge of extinction, and *Balæna mysticetus* will probably go before *B. australis*. Nothing shows this more clearly than the price of whalebone, which has gone up in the last eighty-four years from 56*l.* per ton to 2,100*l.* per ton, or from 12 cents a pound to $4.90, and in some years to $5.80 a pound. The number of pounds on sale in the United States has dropped from 2,916,500 in 1851 to 96,600 in 1906. With the whales will disappear the whale lice and the whole of their very interesting parasitic fauna.

The disappearance of the large game from enormous tracts of country in Africa is too well known to delay us. The elephant, except where preserved in the Litzikama Forest, near Mossel Bay, and in the Addo Bush, near Port Elizabeth, is exterminated south of the Limpopo. The price of ivory again is a measure of the nearness of its extinction. The best pieces, which are used for billiard balls, have risen in price from 5*l.* a hundredweight in 1882 to an average of 100*l.* a hundredweight in 1908. The common and the brindled gnu (*Connochoetes taurinus*) are fated to follow the extinct quagga. The blesbok (*Damaliscus albifrons*), formerly found in thousands in Cape Colony, the Transvaal, and Bechuanaland, is now very rare and seems doomed. The giraffe has long been driven out from South Africa, though it still roams over large tracts of country in east and central Africa.

Perhaps the most striking case is in western Australia. Here many districts are now said to be entirely devoid of indigenous mammals, and this depletion is in the main an affair of only the last thirty years, and many of the local extinct forms are still remembered by the older natives and colonists. Mr. Shortridge, a collector who has worked for some years in southwest and western Australia, writes in a letter: "The entire disappearance of so many species over such large tracts of country is generally considered to be due to some epidemic perhaps brought into the land by introduced animals. It is to be noted that they have died out chiefly in the dry regions, where, except for the introduction of sheep, there has been very little alteration in the natural conditions. Rabbits, although already very numerous in the center and southeast, have not as yet found their way to the northwest." Among the mammals which have almost, if not quite, disappeared from west Australia are the banded wallaby (*Lagostrophus fasciatus*), the hare wallaby (*Lagochestes hirsutus*), the rat kangaroos (*Potorous gilberti* and *P. platyops*). The indigenous rats and mice of Australia are disappearing even faster than the marsupials, and it seems probable that many will not be heard of again.

A very few years ago the ship employed by the company which is exploiting the phosphates of Christmas Island introduced the brown rat (*M. decumanus*) there. Within a short time the two indigenous rats first collected by Mr. C. Andrews, of the British Museum, named *Mus macleari* and *Mus novitatis*, were wiped out of existence. The same animal having been introduced in North America is gradually spreading, and as it spreads the native fauna of Muridae is slowly vanishing.

To adorn our ladies' heads some of the most beautiful of birds are being systematically exterminated. In the London market alone were sold last year some 50,000 sooty terns (*Sterna fuliginosa*, *S. anæstheta*, and *S. bonata*), 20,000 specimens of the crowned pigeon (*Goura*) from New Guinea, their sole habitat, immense numbers of "osprey" feathers, egret and heron, and over 50,000 birds of paradise, or more than double the number of the year before.

When we reflect how greatly we treasure every scrap of knowledge we can glean about such recently extinct animals as the *Rhytina*—Steller's sea cow—the dodo, the great auk, we must see that if it be impossible to check the gradual disappearance of those animals doomed to extinction, we should at least monograph them and take every care that what can be permanently kept of their structure should be kept.

We are living with a disappearing fauna around us, and numerous as the museums of the world are, and skilled and painstaking as the curators of these museums are, they are both wholly inadequate to deal with the material at hand. Some dozen years ago Dr. Günther made a very careful estimate of the number of species of animals which were known in the years 1830 and 1881. I summarize his table:

Number of Species Known in the Years 1830 and 1881.

	1830.	1881.
Mammalia	1,200	2,300
Aves	3,600	11,000
Reptilia and Batrachia	543	3,400
Pisces	3,500	11,000
Mollusca	11,000	33,000
Bryozoa	(40)	120
Crustacea (year 1840)	(1,290)	7,500
Arachnida	1,408	8,070
Myriapoda	450	1,300
Insecta	49,100	220,150
Echinodermata (1838)	(230)	1,843
Vermes (1838)	(372)	6,070
Coelenterata (1834)	500	2,200
Porifera (1835)	(50) *say*	400
Protozoa (1838-44) *say*	(305) *say*	3,300
	73,588	311,653

Taking an average year between 1881 and the present date, but rather nearer the latter, because each year the number of newly described species becomes larger, Dr. Sharp tells me that according to the zoological record 12,449—let us call it 12,450—new species were described in the year 1897.

Number of New Species Described in the Year 1897.

Mammalia	285
Aves	105
Reptilia and Batrachia	140
Pisces	148
Mollusca	1,077
Brachiopoda	7
Bryozoa	6
Crustacea	239
Arachnida	659
Myriapoda	275
Insecta	8,364
Echinodermata	491
Vermes	294
Coelenterata	164
Porifera	95
Protozoa	100
	12,449

This number, however, includes fossils which I do not think were included by Dr. Günther. We might deduct 450 for them if we wish to confine our attention to living animals. This leaves us 12,000. If we multiply this by 27, the number of years which have elapsed since Dr. Günther made his estimate, we find a total of 324,000. This number is possibly too large, as it makes no allowance for synonyms, still it is a rough indication that since 1881 the number of described species has been doubled. Isolated groups, such as the mammals, treated in the same way, give us fairly similar results, so that now we may, I think, say that there are over 600,000 described species of living animals.

It thus appears that during the fifty-one years in the middle of the last century the number of known species grew by some 238,000, giving an average increase of a little under 5,000 per annum. At the present day there are far more workers in the field than there were thirty years ago, museums have multiplied, and there are many more zoologists, and it is now estimated that the number of species annually described and named amounts to some 12,000.

The number, large as it seems, is, however, but small in comparison with the number of species collected and deposited in museums where no one has time to work them out. It is still smaller in comparison with the vast numbers of species as yet uncaptured. Dr. Sharp, in 1895, calculated that there were a quarter of a million known and described insects. This was an increase of 30,000 over Günther's figures of fifteen years before, but he states that in his opinion this quarter of a million is but one-tenth of those which exist.

With the exception of the larger mammalia—though the okapi warns us the exception may yet prove the rule—there is no group of animals which may not yield us new surprises—no group which we can regard as well worked out, though naturally some are better known than others. What, then, are the zoologists of the world doing to record the animal life around them? One thing of late is certainly an improvement. During last century the great zoological collections were in the main increased and augmented by the chance gifts of hunters and sportsmen, whose chief object in their expeditions was not zoology but what is termed "sport." Many valuable gifts are still received from such sources, but it is now recognized that we must not in these matters trust to the sportsman alone. The plan of attaching animal naturalists and experts in taxidermy to an expedition avowedly meant for other purposes is good, and is well exemplified by Mr. Roosevelt's "safari" in East Africa at the present time. We may hope that we may never again see an expedition without a single trained naturalist on its staff, such as the last Stanley led across Africa. A still better plan is to send out expeditions of trained naturalists to do definite pieces of work. Such expeditions as Andrews and Foster Cooper and Osborn to the Fayum for fossils, of Cunnington and Boulenger to the same region to investigate the fauna of the lake, or Wollaston and his companions to the Ruwenzori district, yield a harvest one hundred times more abundant than the best of other schemes.

Yet even here I would plead for a little more organization. One must not suggest too rigid a scheme, and it is to be hoped that in the future, as in the past, there will always be found wealthy men willing to devote their energies to the advancement of zoology. Such work as has been done by Mr. Godman on the fauna of Central America, one of the richest regions in the world, and now, owing to his munificence, one of the best known. The stately array of volumes embodying these results is paralleled by the magnificent monographs in which the results of the Prince of Monaco's marine researches are recorded, and by the monographs of the Princeton Expedition to the Argentine, financed by one of the richest of the millionaires of the United States. We trust that such enterprises will always continue.

With regard, however, to expeditions financed from public funds which are sent out officially, it might be possible to have more international co-operation. Just as the members of the Geodetic Survey meet from time to time and determine the next step to be taken in the triangulation of the world, so it seems to me might the members of the chief museums of the world meet, say, triennially, and draw up certain thought-out plans for the exploration of the zoological world.

With regard to working out the material when collected, the existing museums of the world are too few, and their staffs are too small to deal not only with

* Abstracted from a paper read before the British Association for the Advancement of Science.

the huge collections which are constantly pouring into their buildings, but even with the accumulated stores already housed there. In our smaller State museums it is not uncommon to find men who are responsible for the whole of the Arthropoda. Only within the last few months I have had to try to find a curator for a metropolitan museum who was expected to be a specialist in fishes, mollusks, and arachnids. Now is it possible to expect such men, able and zealous as they are, to accurately determine species in these vast and complex groups? My own feeling is—but I fear I shall carry no one with me—that we must specialize still further. I should like to see each of the great classes of the animal kingdom assigned to one of the great museums of the world. Just as an example—which is only an example, possibly a bad one—I suggest that all the type specimens of Amphibia be sent to one museum, say, if you like, that of Berlin or St. Petersburg; in return for this that museum should distribute to others its types of fish, birds, etc. Then, at this museum there would arise a series of specialists capable of deciding swiftly and accurately on the validity of the claims of any new species of amphibian that may be advanced. Again, a student of Amphibia, instead of wandering round the museums of the world if he wishes to study species, would find all he wants within the four walls of one building. When once the type is described and deposited, it would be the duty of the museum to distribute co-types and accurately named specimens of the same species to other museums in some recognized order. Smaller groups might be allocated to smaller museums, e. g., the fleas to Tring and the ticks to Cambridge. At both of these places there are now specialists working out world collections of these pests. What I want is a world's clearing house for animals. I know I shall be told that my suggestions can never be realized, that international jealousies would prevent such a scheme being adopted, that I am proposing to fetter research. I admit the difficulties, but I do not regard them as insuperable. When you recall the international clearing houses for the postal and telegraphic service, for the banking of the world, and when we reflect what private enterprise does, under the name of Lloyd's, for the shipping of the world, how it registers and describes and certifies with a minuteness not surpassed by any maker of species, each ship in the world; how, through its signal stations and by other means, it follows the daily course of each vessel, so that at any hour of any day it can state where, under normal circumstances, that vessel is, it does not seem to me impossible to come to some understanding as to dealing with the animals of the world. Only by some such means can we hope to cope with the problem before us.

One other fruitful source of "waste of time" I will mention. That is the debatable matter of zoological nomenclature, more especially the questions of synonymy. The British Association at their last meeting passed a resolution on the proposal of Mr. G. A. Boulenger in the following sense:

"The undersigned zoologists, while fully realizing the justice and utility of the rule of priority in the choice of scientific names for animals, as first laid down by a committee of the British Association in 1842, wish to protest against the abuse to which it has been put as a result of the most recent codes of nomenclature, and consider that names which have had currency for a great number of years should, unless preoccupied, be retained in the sense in which they have been universally used. Considering the confusion that must result from the strict application of the rule of priority, they would welcome action leading to the adoption of a scheme by which such names as have received the sanction of general usage, and have been invariably employed by the masters of zoology in the past century, would be scheduled as unremovable."

Mr. G. A. Boulenger expressed disapproval of the extreme application of the rule of priority in zoological nomenclature on the ground that it had already produced much mischief under the pretense of arriving at ultimate uniformity. The worst feature of the abuse of this rule is not so much the bestowal of unknown names on well-known animals as the transfer of names from one to another, as in the case of *Astacus*, *Torpedo*, *Holothuria*, *Simia*, *Cynocephalus*, etc., so that the names which were uniformly used by Cuvier, Johannes Müller, Owen, Agassiz, Darwin, Huxley, and Gegenbaur would no longer convey any meaning; very often they would be misunderstood, and the very object for which Latin or Latinized names were introduced would be defeated.

The International Congress of Zoology takes, I believe, a somewhat sterner view, but they are engaged in drawing up a list of names which they hope will be accepted for all time. I for one am prepared to accept them, and I am prepared to go further. I would ask the International Congress if, instead of drawing up a list of single species, or perhaps in addition to it, they would draw up a list of systematic monographs, the names in which may be regarded as final. After all, modern classification began with a book, and it would take no longer, or very little longer, to sanctify a book which may contain diagnoses of hundreds of species than to sanctify the single species. The idea is due to Mr. Cyril Crossland, and he suggests—he was working at Chaetopods—that such works as Claparède's "Annelides Polychètes du Golfe de Naples," Ehler's "Die Borstenwürmer," McIntosh's "Monograph of the British Annelids" be accepted. Possibly whole categories of books might be considered, such as the "Challenger Reports," and especially "Das Tierreich," the admirable volumes of which we owe to the enterprise of the Berlin Zoological Society. Such a scheme would certainly cause some minor injustices, but every scheme does that. The immense advantage of allowing a researcher to readily determine and give an accepted name to an animal he is investigating without waiting weary days in struggling through a vast and scattered literature for the sake of synonymy would surely far out-balance any temporary injustice.

One last phase of my subject and I have finished with what I want to say on the subject of organizing zoology. In Europe the great museums of our metropolitan towns are state museums, endowed by the state, managed by the state, and in Great Britain and Ireland staffed and curated by the state; that is to say, the officials at the museums are civil servants. Let us consider for a moment what that means, and let us take the British Museum, which, in its entirety, is second to none in the world as an example of a state museum.

The British Museum was established by an act of Parliament in the year 1753 (26 Geo. II. cap. xxii). This act sanctioned the purchase of collections and library of Sir Hans Sloane, that prince of collectors, for the comparatively insignificant sum of £20,000. In fact, Sir Hans left his magnificent collection of natural objects, which, twenty years before his death, amounted to just under 70,000 specimens, his library of 40,000 printed volumes and 4,100 manuscripts, to the nation, on condition that £20,000, about one-fourth of the estimated value of the collections, be paid to his executors. Under the above-mentioned act £10,000 was paid to each of Sir Hans Sloane's daughters, Mrs. Stanley and Lady Cadogan. The same act provided £10,000 for the purchase from the Duchess of Portland, heiress of the second Earl of Oxford, of the Harley collection of charters and manuscripts, which were then in the market, and other moneys for the purchase and repair of Montagu House, Bloomsbury, and for maintenance. The act incorporated with the museum the Cottonian Library at Westminster, which, by an act of Parliament of William III.'s reign, was under the care of trustees, chief among whom were the Archbishop of Canterbury, the Lord Chancellor, and the Speaker; the money was raised by a lottery, and the museum was opened in January, 1759, just 150 years ago.

Now it will be noticed that at its formal birth the museum consisted of about two equal parts—on the one hand books and manuscripts, and on the other what used to be called "natural objects."

The "General Repository," as the act of George II. called it, was placed in the hands of a body of trustees, now forty-nine in number, three of them relics of William III.—namely, the Archbishop of Canterbury, the Lord Chancellor, and the Speaker of the House of Commons, are trustees by virtue of office. These three are known as the principal trustees; there are twenty-one other trustees in virtue of their office, e. g., the Bishop of London, the President of the Royal Society and Royal Academy, and so on; one is appointed by the Crown, nine represent the families of donors, and fifteen are co-opted. So large and unwieldy a body cannot, as a whole, transact the business of a great museum, and they have largely delegated their functions to a standing committee of the three principal trustees and fifteen annually appointed representatives.

Now the manner of appointing to the museum is this: The junior members of the staff are selected as the result of examination, and when appointed they become civil servants. Not a bad thing in itself, but bad for a man of science. He, through no fault of his own, becomes entangled in red tape; above all, he must not make himself a nuisance; *trop de zèle* must be avoided, his enthusiasms tend to become checked, he is perpetually observing what is called "official reticence," and he perforce spends his days in performing routine work during routine hours. No amount of skill and ability—and the staff at the museum is both skilled and able—hasteps his promotion. This is a matter almost entirely of seniority. In fact, the conditions of the civil service are incompatible with that freedom of research in any line that proves most suggestive, and with that absence of outside control which alone makes scientific research on a large scale possible.

The appointment to the senior staff, the keepers or heads of departments, the Director of the Natural History Museum, and the chief librarian, are vested in the three chief principal trustees. This takes us back to the reign of William III. and the Cotton Library at Westminster. No doubt the then Archbishop, the then Lord Chancellor, and the then Speaker, both from propinquity and from their abilities and training, were quite the best men who could be found for this position of trust toward this library. Probably the present holders of these exalted positions—positions which they most worthily fill and which give two of them precedence after royalty in all Britain—are most fully endowed with the qualities which fit them to elect the senior staff for the library and for the collections of works of art and of antiquities at Bloomsbury. I doubt if the same eminent qualities enable them to deal equally satisfactorily with the higher posts in the Natural History Museum. If Parliament, or indeed any other body, were framing a scheme for the management of a great museum of science at the present time, I do not think it would occur to anyone that the holders of the exalted offices I have mentioned were specially fitted, either by the knowledge of the pressing scientific needs and problems of the moment or by their intimacy with the men of science of to-day, to be the most competent electoral body to choose keepers in geology, mineralogy, botany, and zoology. And, indeed, the existing arrangement has broken down. I do not know how long before Sir E. Ray Lankester's resignation of the joint posts of director and keeper in zoology, in December, 1907, it became known to the trustees that that resignation was imminent, but I do know that it was talked about and written about months before that date. Yet after the resignation took effect one whole year elapsed before the trustees appointed a keeper in zoology; for twelve months there was no head of a department which contains collections unrivaled in the world. It took the trustees about six months longer to find a director, and for about eighteen months the charge of this great museum of natural history was vested, under the trustees, in the Chief Librarian at Bloomsbury.

As Prof. Ronald Ross could testify, after scientific research has placed it within the power of man to exterminate so deadly a disease as malaria, the real fight begins; and the real fight is to persuade the authorities to adopt and enforce the measures which are offered them gratis. There is a case in point, if I am not misinformed, on this continent at the present time. It has been known since the time of the making of the St. Gothard Tunnel that lasting and often fatal disease is caused by a small intestinal worm, known as the tunnel-worm or hook-worm. Within the last few years Dr. Wardell Stiles has shown quite clearly that the unhappy condition of "poor whites" of the southern United States is due largely to their being affected by this hook-worm. Their bodies and their intellects are arrested in their development, and the adults among them are unable to understand the prophylactic measures he advocates, but the children can be taught if the proper organization existed for teaching them. Many of the Southern States are friendly to the movement, and I know of no greater service that the central government of the United States could confer upon the inhabitants of these southern States, in which, as is well known, President Taft takes the deepest interest, than that of detailing Dr. Stiles for several months each year to organize and control this movement. If this could be done, I believe—and I am here speaking of those things that I do know—the United States government would confer on their own people a benefit as great as they conferred on other nations when they freed Havana of yellow fever and Panama of malaria.

"The entire art of the trainers of wild animals," writes Pierre Hachet-Souplet in his investigation into the psychology of animals, "consists in their availing themselves of the fear of their pupils, and in driving them wherever they wish to. As soon as one opens the cage of a wild animal, it flees to the opposite side. If one does not proceed farther, it remains in a crouching posture and places itself upon the defensive. If one approaches the animal with threatening mien, it attempts to get away. It is necessary only to give it a path of escape, otherwise one will be attacked. One follows it thus from one corner to another; if it finds an obstacle to its flight, it without ado vaults over it. Animal trainers have no other secrets. Their art consists mainly in making these procedures dramatic, in that they make it appear, as far as possible, as if they were conquering the will of the animal; thus—for sake of the impression—they hesitate for a moment before causing the animal to spring over a barrier, by a slight forward motion on their own part; the whole thing is made more vivid by the cracking of whips."

The suitability of the Quebec bridge piers for the new bridge now being designed has been questioned. The Engineering News states that the new design demands a bridge much heavier than the old, and the three members of the Board of Engineers are unable to agree upon the ability of the masonry piers to carry this increased load. It will be remembered that, so far as external investigation could show, the piers of the Quebec bridge were not at all damaged in the fall of the superstructure.

ENGINEERING NOTES.

The Canadian Railway Commission has issued an order compelling every railway in Canada to have the whole of its right-of-way properly fenced in by January 1st, 1911. The order states that the fence must be of a minimum height of 4 feet 6 inches, and gates must be provided at every farm crossing. At every level highway crossing there must be adequate cattle guards. The width of approaches to level crossings must be 20 feet on concession and main roads and 16 feet on side and bush roads.

A series of comparative tests on the case-hardening power of various gases, the results of which were communicated by Olsen and Weiffenback at the recent Brooklyn meeting of the American Institute of Chemical Engineers, have shown that the case-hardening effect of carbon monoxide is greater than that of acetylene or methane. It is stated that the carbon monoxide process has been applied to commercial case-hardening, and that a patent covering it has recently been taken out in France.

The circular railway which serves some portions of Perlin and its suburbs was the scene of a curious accident on Thursday, August 19th. An iron tower on the premises of the Imperial Gas Company at Schoneberg, which are skirted by the line, collapsed shortly before midday, just as a train was passing by. The tower was about 280 feet high, and was intended for the storage of material for a new gasometer. The fragments in their fall wrecked the last compartment of the passing train. One person was severely injured, while four others were slightly hurt. Traffic on the railway line was subsequently restored.

There is much interesting matter in the report of the Block Signal and Train Control Board to the Interstate Commerce Commission, giving the American view of European methods. One section of the report, the Railway News states, deals with devices or systems which have to do with the safety of railway operation. It is pointed out that while English roads evidently have, as a whole, the best of signalmen, a number of companies have, nevertheless, introduced electric control apparatus by which the men at the opposite ends of a block must co-operate in giving a clear signal. Whether from a knowledge of errors which have occurred but which have caused no collisions and have not been made public, or from the desire to provide all possible safeguards, which, no doubt, is the real reason, these roads have taken action further to protect passenger services.

According to the Railway Times, Sir Charles Metcalfe, who left England in March in connection with the further extension of the Cape to Cairo Railway, has just returned to England from the Congo. He states that 60 miles of earthworks have been completed beyond Broken Hill, and that the rails are being laid at the rate of one mile daily. It is expected that the railway will be at the frontier itself by the end of the year. There will then be direct through rail communication of some 2,150 miles from Capetown and of 1,450 from Beira. With a railway from Albert Edward Lake to the north end of Tanganyika, and a line from the existing system in northwest Rhodesia through northeast Rhodesia, to develop that region, which is all 5,000 feet to 6,000 feet above sea level, travel by rail or steamer will be possible the whole distance from Alexandria to Capetown.

Construction work on the new section of the Cape to Cairo Railway has already commenced, says the South African Railway Magazine, and 2,000 tons of rails are being shipped weekly. The railhead is still at Broken Hill, 375 miles north of the Victoria Falls, where it has been for the past year, pending the completion of negotiations as to the construction of the extension northward. From its present terminus, the line will run due north as far as the Congo border, and beyond there will strike northwest along the copper belt and past the various mines. It is hoped that the new section will be completed this year, and that copper from the mines at Bwana Machuwa, near the frontier, will be transported over the Rhodesian system before a year has elapsed. When the boundary is reached there will be about 2,200 connected miles of railways from Capetown to the Congo. As to the further extension of the Cape to Cairo line, it is probable that extensions will be made northward in the Congo territory.

Most of our readers are familiar with the natural development of American hamlets into large and flourishing cities. In the case of Gary City, however, we have a unique example involving the design and construction of a town complete with all the most recent installations and services for the public welfare and convenience. Owing to the establishment of the Gary Steel Works on the shore of Lake Michigan it became necessary to provide housing accommodation on a large scale, the result being that the United States Steel Corporation formed two subsidiary companies—one for the acquisition of land and the building of a complete town for several thousands of inhabitants, and the other for the establishment of water works, drainage works, and heating and lighting systems. The former company have already built more than 500 houses along wide and well-planned main thoroughfares, while three school houses and a public library are nearing completion. Including buildings erected by private owners the town now provides for the population of 15,000 persons on a site which three years ago was practically waste land on the borders of the lake.

ELECTRICAL NOTES.

The House of Brown-Boveri of Baden (Switzerland) have installed the electrical power station for utilizing the power of the falls of Rjukan in Norway. Our readers will know that these falls, which are near those of Notodden, are utilized in fixing atmospheric nitrogen in the form of nitrated fertilizer. The machines made by Brown-Boveri are five three-phase generators of 17,000 kilowatts each; they will generate current at a potential of from 10,000 to 17,000 volts, with a frequency of 50 cycles. They will be driven by hydraulic turbines of 16,000 horse-power revolving 250 times per minute. The installation at Rjukan will be, when assembled, the most powerful in Europe. It will have no equal in the world other than the hydro-electric plant used by the city of Rio de Janeiro.

La Compagnie Allemande d'Electricité Transatlantique, which holds, in fact, the monopoly for furnishing current for lighting and traction in Buenos Ayres, have decided to replace their diverse plants by one unique central station, which is actually in course of construction, and which promises to be among the most important in the world. The estimated power amounts to 110,000 steam horse-power, which will be furnished by ten turbine alternating generators of 11,000 horse-power each, constructed by Brown-Boveri in Mannheim and by Franco Tosi in Legnano. Each turbine is able to give an overload of 14,200 horse-power during ten hours, and without the least inconvenience. The estimated velocity is 7,500 revolutions, with a consumption per kilowatt of only 6,300 grammes of steam at a pressure of 12.5 kilogrammes. The necessary steam will be furnished by sixty Babcock & Wilcox boilers. The coal stoking will be entirely automatic; each boiler will be provided with a superheater, permitting the attainment of a temperature of about 350 deg. C. The installation of five groups each of thirty boilers is being carried out.

Wireless telephony is being rapidly developed in France by the labors of Lieuts. Colin and Jeance, of the French navy. In their official experiments, last April, these officers succeeded in telephoning between Eiffel Tower in Paris and the town of Melun, about 25 miles distant. In June they established wireless telephonic communication from Toulon to a ship cruising at distances of from 68 to 108 miles. In August transmitting apparatus was installed at the naval station near Toulon and receiving apparatus was placed at Port Vendres. The air-line distance between the two posts, across a bay of the Mediterranean, is about 150 miles. The experiment was continued two hours, during which every word spoken by Colin at Toulon was heard, loudly and distinctly, by Jeance at Port Vendres. The experimenters are confident of the power of their apparatus to transmit speech distinctly to a distance of about 200 miles. In these experiments regular and sustained electric oscillations were produced by Poulsen's device, consisting of a number of electric arcs, arranged in series and operated at a tension of 600 volts. These oscillations were then modified and modulated to agreement with the vibrations of the human voice by the action of a specially devised microphone, or rather, of a large number of microphones arranged in series.

According to Exner, the negative potential of the earth is 9×10^5 volts, and its charge 6.7×10^5 coulombs. The potential gradient varies from 1,000 to 10,000 volts per meter, the latter value being often observed in thunderstorms. These gradients are capable of producing dangerous charges in balloons carrying fairly large metallic parts or parts thoroughly wetted. The valves are the most dangerous fittings, especially as the gas issuing from them is easily ignited. They are even dangerous to touch after a landing. Lightning discharges produce sudden reversals of the potential gradient, and induce charges within the balloon. All parts in contact with the balloon bag should be non-metallic. Metallic fittings on the motor and the car are innocuous. Rigid balloons of the Zeppelin type are particularly liable to destruction by atmospheric electricity. They might be safely guarded either by replacing the aluminium frame by a wooden frame, or, on the other hand, by making the whole cover of thin sheet metal, preferably corrugated. The weight of such a covering may be kept below that of a non-metallic cover. Such a metallic covering would offer complete protection against internal ignition, and would have the additional advantage of being incombustible. Wireless messages could be dispatched from such a balloon with safety. Aeroplanes are not in any danger from atmospheric electricity even in a thunderstorm.

TRADE NOTES AND FORMULÆ.

Lemon essence is made by chopping up cut and dried lemon peel with a chopping knife and in wide-mouthed, 10-quart jars, pouring over the choppings the finest 90 per cent alcohol and allowing it to extract for eight days in not too cool a place—a temperature of 66 deg. to 68 deg. F. being the most suitable. After this time pour the essence off from the skins, press them out, and filter through a paper filter. The best proportion is 1 part peel to 2½ parts alcohol; hereby we obtain a concentrated essence, but one may also use the ratio of 1 to 5. The extract should be kept in bottles, not too large and likewise in a cool, dark place.

Cerealine is a preparation of Indian corn, used as a food, also in brewing. The dry, cleansed grain is not at first crushed, but first steamed for a minute in a cylinder with revolving arms at a temperature of 352 deg. F. by steam under 6 atmospheres pressure. Then the corn is coarsely ground and screened. The residue, consisting of husk, large particles and germs, is divided into various granular sizes, and the germs, as long as they remain soft, are separated mechanically from the harder granules rich in starch. The cleansed granules are again treated with steam and thereby softened and in their softened condition pressed between heated rollers and dried.

Writing on Sheet Zinc.—In place of the expensive chloride of platina it is better to use a solution composed of equal parts of chlorate of potash and blue vitriol in 18 times the quantity of warm water, to which solution a little gum slime (mucilage) has been added. The plate to be written on is first cleansed thoroughly and the writing then traced on it with the above solution, which is allowed to act for a moment and then rubbed dry with a woolen rag smeared with soap (a portion of the following soap as large as a pea): 1 part yellow grain soap, 3 parts Japan wax, 21 parts distilled water, boiled for 1½ to 2 hours, so that the wax and soap are perfectly dissolved and a homogeneous mass obtained.

Tin Moiré.—A simple means of producing tin moiré on sheet tin consists in the employment of iron alum. If tin plates, cleansed from grease, are coated cold with a solution of 100 parts of iron-alum in 1,000 parts of water, there will be produced at once the most beautiful tin crystals causing the so-called moiré. The grease can best be removed by rubbing with a cloth, moistened with ether or ligroine. Chalk, as well as Vienna lime, must be avoided. The sheets, after cleansing with water, can be given colored decorations in the customary manner with brilliant varnishes. Iron chloride must not be used in place of iron alum. It will bring out the tin crystals, it is true, but owing to the simultaneous formation of stannous oxide, they will be colored grayish black.

Polishing cloths are coarse fabrics, which are steeped either in water, in which abrading material, very finely pulverized, is mixed, or in water glass. If we soak a fabric, which of course must not be finished, in water in which emery, brick-dust, chalk, etc., in finely pulverized condition is mixed and kept suspended by constant stirring, and after it is thoroughly saturated and wrung out hang it up to dry, the fine abrading material will remain attached, partly in the interstices and partly to the fibers, and one can then use such a fabric for polishing purposes. If we add an adhesive, the abrasive material will hold better, but the fabric will be harder and stiffer. If a piece of coarse linen is immersed in a water-glass solution of 30 deg. Bé, after the fabric is saturated, rinsed out quickly in cold water, and then dried it will have absorbed so much water glass that the crystals of silicic acid formed, on account of their hardness and sharpness make it an excellent polishing medium. Two parts of emery, 12 parts of oxide of iron are mixed into very weak glue water and prevented, by constant stirring, from settling and the linen or other fabric steeped in it so that it is quite saturated with the fluid; then wring it out and hang it up to dry.

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